SIXTH
ANNUAL PROGRESS REPORT
concerning
BREEDING AND DEVELOPMENT
OF BENTGRASS

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SIXTH ANNUAL REPORT NOVEMBER 1990

BREEDING AND DEVELOPMENT OF BENTGRASS

EXECUTIVE SUMMARY
SIXTH ANNUAL BENTGRASS REPORT 1990
BREEDING AND DEVELOPMENT OF BENTGRASS

Principle Investigator: M. C. Engelke
Research Associate: V. G. Lehman (Through August 1990)
Research Assistant: M. S. Wilson (Begin Feb 1990)
Research Period of this Report: November 1989 to November 1990

The bentgrass breeding program has completed its sixth year of funding by the USGA/GCSAA - Bentgrass Research, Inc. As a major milestone, and enclosed within this report are PETITIONS TO RELEASE for three creeping bentgrass varieties developed by Texas A&M and the United States Golf Association. The initial petition for release of Syn3-88 was filed 14 September, 1990, Syn4-88 was filed 4 October 1990, and Syn1-88 was filed 23 October 1990. Foundation seed production fields were established for Syn3-88 (10 acres) and Syn4-88 (12 acres) in September 1990. Foundation production of Syn1-88 will be planted in the spring of 1991 (~10 acres). The anticipated production cycle will permit certified production fields of Syn3-88 and Syn4-88 to be established in 1991, with the first commercial production to be harvested and available to the industry by the fall of 1992. Syn1-88 production cycle will lag by 1 year with first commercial production available in 1993.

Reselection, hybridization, and advanced screening programs rapidly advance with the production of 14 new polycross populations, and 24 single cross populations being produced in 1990. By count we presently have over 9000 individual plants established in the greenhouse for additional screening and evaluation. Specific emphasis over the next few years will be on the development of multiple character attributes into new varieties. Heritability work is being rapidly pursued for disease resistance mechanisms, drought and heat tolerance characters, and perennial root growth characters as effective screening procedures are being developed.

The leaf-stem hydration work completed by Virginia Lehman suggests that a very strong relationship exists between leaf water content and heat tolerance. This procedure will be used extensively, along with the flexible tube procedure, for screening root characters of bentgrass in the development of the next generation of superior varieties.

Assessment of genotype performance continues in the greenhouse, field and laboratory, with screening of germplasm. Superior plants are being identified and recycled in the breeding program. Invaluable cooperation continues from Pickseed West, with Dr. Jerry Pepin and Mr. Doug King.

SIXTH ANNUAL BENTGRASS REPORT 1990

M. C. Engelke, V. G. Lehman, and Mary Sue Wilson

I. INTRODUCTION

The bentgrass breeding program is a cooperative research project funded jointly by the Texas Agricultural Experiment Station (TAES), the United States Golf Association (USGA), and Bentgrass Research, Inc. (BRI). This project was initiated in Apr. 1985. Semiannual progress reports are submitted 1 May, and annual reports are submitted 1 Nov. each year. This report, with the May 1990, semiannual report, constitutes the 1990 Annual Progress Report for the Bentgrass Breeding Program.

II. PROFESSIONAL AND TECHNICAL SUPPORT

Virginia Lehman, Research Associate, completed her Ph.D. program in Plant Breeding in May 1990. She resigned her position with the program to assume a plant breeding position with Lofts Great Western Seed Co., Albany, OR. Ms. Sue Wilson, Research Assistant, assuming more responsibility for the daily operation of the project, is very competently continuing to manage the breeding program with implementation of screening techniques and germplasm management. Ms. Wilson holds a B.S. degree in Plant Science from Clemson University (1979). Ms. Wilson is currently attending Collin County Community College, taking prerequisite classes for graduate studies. Ms. Katrina Porter, a December 1989 graduate in Horticulture, Texas A&M University, has been employed since May 1990 as a student technical assistant.

III. IMPLEMENTATION

A. GERMPLASM ASSESSMENT

INTRODUCTION: Evaluation of the plant materials is necessary to determine which traits are meritorious to include in a breeding program. The evaluations include intensive screening programs in the laboratory, growth chamber, and greenhouse to limit expensive field evaluations to only the most promising genotypes.

1. GREENHOUSE

a. Heritability of hydration character

OBJECTIVE: Determine if the character of hydration (g of water per g of dry shoot tissue weight) is heritable.

JUSTIFICATION: During 1989-1990, seven individual studies were conducted in which approximate 1/2 g samples of shoot tissue were harvested from the RHT (Root heat tolerant) plants which were maintained under soil heat stress. The population of plants originating from 'Seaside' creeping bentgrass that survived elevated soil temperatures possessed 10% more water per g of dry shoot tissue weight. This character, if heritable, could indicate that the surviving plants could continue to transpire and maintain the cooling mechanism of evapotranspiration.

PROGRESS: On 15 February 1990, 10 parental clones and their respective half-sib progeny were planted in a cable bench for exposure to elevated soil temperatures. The study was arranged in a randomized complete block design with four replications. A replication is composed of two samples of each parental clone and five half-sib progeny of each parental clone. The procedure consisted of harvesting approximate 0.1 g of shoot tissue from each plant with scissors and placing the tissue in coin envelopes. The envelopes were placed inside a foam ice chest as harvested in groups of seven plants. The tissue was weighed to the nearest 0.01 mg. After weighing, the tissue was air dried at 50 C for 24 hours, and reweighed. Hydration (g water) was determined by (wet weight - dry weight) / dry weight. The entire study was repeated in the greenhouse during the summer of 1990.

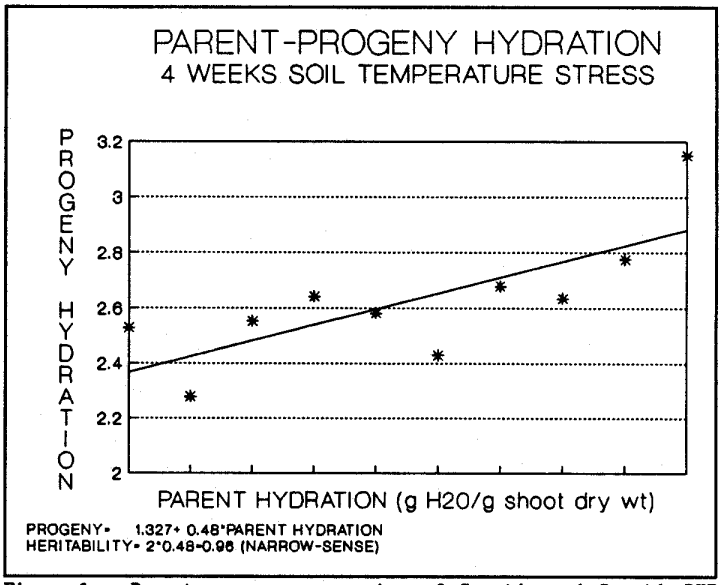

Figure 1. Parent progeny regression of Seaside and Seaside-RHT selections for leaf-stem water hydration.

The parental clones exhibited differences in hydration when grown under non-stress soil temperatures (Table 1, 0 week stress). The rank correlation between parent and progeny hydration was non-significant. When grown under soil temperature stress for 2 and 4 weeks, there was a significant rank correlation between parent and progeny, indicating selection for increased hydration would have to be conducted under stress conditions. Parent-progeny regression indicated hydration, as measured with this population and under these conditions, was a highly heritable character (Figure 1).

Results of the second study (July-August 1990) were consistent with the first in rank correlations of parental response after 4 weeks of soil stress. Parent and progeny had significant rank correlations after 2 and 4 weeks of soil stress, consistent with the results from the first study (Table 2).

b. Cultivar Hydration

OBJECTIVE: Determine if cultivar differences exist between commercial cultivars and three experimental lines of creeping bentgrass.

PROGRESS: In the spring of 1990, 1.27 cm diameter soil cores were harvested from field plots of nine commercial bentgrass cultivars and three experimental cultivars. The plugs were cut to 2.5 cm in length, and planted in a fritted clay soil, approximately 15 cm in depth, inside plastic tubs with drainage holes. The plants were clipped and maintained at a 2.5 cm clipping height, with clippings removed, and fertilized at a rate of 25 kg ha-1 for N, P_2O_5, and K_2O using a soluble 20-20-20 formulation every 2 weeks. The plants were arranged in a randomized complete block design with four replications. Each entire block was repeated a total of six times, resulting in 24 measures of hydration to constitute a cultivar mean for each sampling date. Hydration was measured as in the heritability studies (see section 1A.).

Significant differences in hydration were found among cultivars at 0, 2, and 4 weeks soil temperature stress (Table 3). Shifts occurred in rank hydration between the 0, 2, and 4 week stress periods. Syn4-88, ranking 8 in hydration at 0 weeks, ranked first after 4 weeks stress. Penncross ranked 2nd in hydration at 0 weeks, and lost hydration while under soil temperature stress, ranking 7th after 4 weeks stress.

FUTURE WORK: The hydration character was measured after six weeks stress, with the data yet to be analyzed. The procedure will be an effective screening tool and will be used to further assess the germplasm nursery of all bentgrasses as a matter of routine procedure.

2. FIELD - Agronomic assessment

OBJECTIVE: Identify genotypes with superior agronomic traits on a sand green with management similar to a putting green.

JUSTIFICATION: Evaluation of the plant materials on a sand green identifies genotypes under a given environment.

a. Field evaluation trials

1) Regional Trials - PROGRESS: As reported in the 1989 reports, parental materials tested from 1985 to 1988 were utilized in production of three potential cultivars - Syn1-88, Syn3-88, and Syn4-88. For comparison purposes, cultivar evaluations were seeded on 31 October 1988 with nine commercial cultivars at Dallas. A similar study was seeded at Augusta National Golf Club, Augusta, GA, in November 1988, with the cooperation of Dr. Gil Landry, Extension Specialist, Univ. of Georgia. At the Dallas site, fertilization was applied at a rate of 439 kg actual N ha-1 during 1989. A traffic machine, consisting of 550 golf spikes mounted on two rollers having a 17% rotation differential, was utilized to simulate foot traffic, beginning in October 1989, with a minimum of two passes per week. Irrigation was applied as needed to prevent stress. Quality ratings were made on a scale of 1-9, with 9=best, and included the components of density, texture, color, uniformity, grain, and freedom from diseases and weeds. During August and September, the cultivars at Dallas experienced pressure from melting out (Helminthosporium spp.) and Pythium spp. Notes were taken regarding susceptibility, and pesticide application was necessary to prevent total loss of plots.

2) National Turfgrass Evaluation Program - Greens - PROGRESS: - Syn1-88 was included in 16 test locations of the NTEP bentgrass test. Syn3-88 and Syn4-88 were distributed to Dr. Charles Mancino, Dr. Richard Cooper, Dr. Bob Carrow, and Dr. Jeff Krans to be planted in conjunction with the National Trial. Data from these test locations will be included as it becomes available.

The modified greens test was planted at Dallas on 10 October 1989 at a seeding rate of 0.44 lb. per 1000 sq. ft. This planting established well, with approximate 80% cover by all cultivars by April. During the week of 1 October 1990, plots which were originally planted with ryegrass as spacers were removed and seed of Syn3-88 and Syn4-88 were planted from the 1990 Oregon seed harvest.

The West Palm Beach test location provided some excellent disease screening information early in 1989. An irrigation malfunction resulted in death of over half of the plots in the summer of 1990. A field trip to Banyan Country Club will be made the week of 12 November 1990 to access the present status of the test and to determine if replanting will be necessary.

3) National Turfgrass Evaluation Program - Fairway - PROGRESS: - Syn1-88 was included in the 1989 NTEP fairway tests. This test was planted at Dallas on 30 November 1989 on native soils. This test continues with minimum maintenance.

b. GERMPLASM ASSESSMENT - Dallas: The evaluation of the GPIN nurseries continues in the field in Dallas. Three individual blocks now encompass approximately 1/2 the plantings under greens maintenance. During October 1990, Dr. Jane Breen, Rutgers Univ., will be assessing the bentgrass collection to determine if the materials contain an endophyte which could be exploited for enhanced performance.

B. SEED PRODUCTION OF SYNTHETIC CULTIVARS

OBJECTIVE: Produce seed of the three synthetic cultivars; Syn1-88, Syn3-88, and Syn4-88.

JUSTIFICATION: Provide seed for testing by research cooperators and to establish foundation seed production fields.

PROGRESS: Approximately 34, 30, and 22 lbs. were produced of Syn1-88, Syn3-88, and Syn4-88 respectively in 1990. The breeders seed production sites will continue for Syn3-88 and Syn4-88 for seed production in 1991 and 1992, after which the fields will be destroyed. Due to the location of Syn1-88 it was necessary to remove the breeder field following seed harvest in 1990. This nursery will be replanted in November 1990 for additional seed production in 1991 and 1992.

See section B below. Increase acreage of Syn3-88 and Syn4-88 was planted in September 1990. Increase acreage of Syn1-88 will be planted in the spring of 1991.

C. SEED PRODUCTION AND HYBRIDIZATION OF ELITE GERMPLASM ACCESSIONS - OREGON: With the assistance of Dr. Jerry Pepin, Pickseed West, Tangent, OR., approximately 30 clones of bentgrass were evaluated for seed production characters. In June 1990, 14 individual polycrosses (Table 4) were developed based on floral characters as exhibited in Oregon and turf qualities as exhibited in Dallas. Group N was specifically developed as a polycross of disease resistant clones identified in cooperation with Dr. Phil Colbaugh. Several of these clones were included in other crosses as well to further increase the level of disease resistance in the population. Seed from these crosses, and 24 individual single crosses (Tables 5 and 6) were germinated during September and October in the greenhouse, and will be planted in field and greenhouse nurseries for additional testing, evaluation and reselection. These single cross populations were specifically developed for heritability studies on disease resistance, root growth characters, hydration performance and other heat tolerance mechanisms.

D. VARIETAL RELEASE DOCUMENTATION

OBJECTIVE: Prepare necessary documentation to include Petitions to Release of Syn1-88, Syn3-88 and Syn4-88.

JUSTIFICATION: Three bentgrasses under development, increase and evaluation have proven superior in performance for agronomic characters at Augusta, Georgia, Dallas, Texas, and West Palm Beach, Florida, in comparison to commercial cultivars presently available. Breeder blocks of each of these were established in Oregon in 1989 with the first major seed harvest in 1990. Seed increase blocks were established in September 1990 for Syn3-88 (10 acres) and Syn4-88 (12 acres), which will be classified as foundation stock for harvest in 1991. Approximately 10 acres of Syn1-88 will be established in spring 1991, with the first harvest for 1992.

PROGRESS: Copies of each of the three PETITIONS TO RELEASE are included in the appendix. Syn3-88 and Syn4-88 have cleared the Technical Review Committee. Syn1-88 was submitted to the Technical Review Committee October 22, 1990. Once cleared, all three Petitions will be submitted to the **PLANT IMPROVEMENT REVIEW COMMITTEE** for approval for release. Following favorable committee action, industry representatives will be notified of cultivar availability with a solicitation of bids for LICENSES AGREEMENTS for PRODUCTION, MARKETING AND DISTRIBUTION.

Table 1. Hydration (g water per g dry shoot weight) of ten parental (Par) creeping bentgrass clones and their half-sib progeny (Prog) under 0, 2, and 4 weeks soil temperature stress, April-May 1990.

	Hydration					
	Number Weeks Stress					
	0		2[1]		4[2]	
Clone	Par	Prog	Par	Prog	Par	Prog
	g water/g dry shoot tissue					
404A	3.73	3.15	3.55	3.05	2.90	2.68
204R	3.60	3.05	3.38	2.95	3.05	2.78
703A	3.51	3.46	3.25	3.30	3.29	3.15
505A	3.49	3.15	3.40	2.97	2.92	2.64
401R	3.46	2.96	2.70	2.75	2.04	2.53
604R	3.40	2.89	3.13	2.71	2.56	2.43
307A	3.29	3.31	3.17	2.90	2.54	2.58
503A	3.24	2.98	3.31	3.02	2.51	2.64
304R	3.20	2.95	3.08	2.76	2.47	2.55
2735	3.45	3.05	3.33	3.09	2.19	2.28
LSD*	0.47	0.21	0.44	0.23	0.34	0.17

[1]Significant Rank Correlation (r_s=0.65, p<=0.05)
[2]Significant Rank Correlation (r_s=0.78, p<=0.01)
*F protected LSD (p<=0.05).

Table 2. Hydration (g water per g dry shoot weight) of ten parental (Par) creeping bentgrass clones and their half-sib progeny (Prog) under 0, 2, and 4 weeks soil temperature stress, July - August, 1990.

	Hydration					
	Number Weeks Stress					
	0		2[1]		4[2]	
Clone	Par	Prog	Par	Prog	Par	Prog
	g water/g dry shoot tissue					
404A	3.14	2.45	2.41	1.87	2.52	2.23
204R	2.70	2.19	2.16	1.68	2.02	1.83
703A	2.67	2.29	2.05	1.69	2.18	1.86
505A	3.04	2.42	2.24	1.96	2.02	2.09
401R	2.24	2.19	2.00	1.63	1.84	1.87
604R	1.98	1.86	1.86	1.57	1.81	1.59
307A	2.64	2.18	2.33	1.95	2.11	2.14
503A	2.47	2.42	1.87	1.71	1.72	1.81
304R	2.19	2.20	1.89	1.70	1.89	2.00
2735	2.32	2.12	1.70	1.66	1.61	1.62
MCT*	0.23	0.26	0.26	0.19	0.29	0.21

[1]Significant Rank Correlation (r_s=0.68, p<=0.05)
[2]Significant Rank Correlation (r_s=0.72, p<=0.01)
*F protected Multiple Comparison Test (p<=0.05).

Table 3. Hydration, measured as g water per unit dry shoot weight, over time while under soil temperature stress of three experimental and nine commercial cultivars of creeping bentgrass.

Cultivar	Weeks of Stress: 0		2		4	
	Hydration: g	Rank	g	Rank	g	Rank
Cobra	3.91ab*	9	3.18abc	7	3.27d	11
National	4.05ab	4	3.18abc	6	3.37bcd	8
Pennlinks	3.90ab	10	3.10bc	10	3.36bcd	9
Penncross	4.05ab	2	3.25abc	4	3.42bcd	7
Putter	4.01ab	5	3.26abc	3	3.57ab	2
SR1019	3.99ab	6	3.35a	1	3.50abc	5
SR1020	4.09a	1	3.23abc	5	3.50abc	4
Seaside	3.81bc	11	3.12cd	9	3.35bcd	10
GW	4.04ab	3	3.32ab	2	3.51abc	3
Syn1-88	3.99ab	7	3.09cd	11	3.46abc	6
Syn3-88	3.64c	12	2.94bc	12	3.27d	12
Syn4-88	3.97ab	8	3.14bc	8	3.66a	1

*Means followed by the same letter are not different using least-square means ($p<=0.05$).

Table 4. A listing of the 1990 Polycross populations developed in Tangent Oregon June 1990. Each population will be referenced as a Synthetic (SYNx -90), where x = A thru N. The information presented is of the number of progeny successfully produced, germinated and established in the greenhouse in 1990.

	Polycross population or SYNx-90														
TAES Accession#	A	B	C	D	E	F	G	H	I	J	K	L	M	N	
2784				108								108			
2794		3						72							
2798		72													
2799		29					72								
2831					108			72				39			
2833			108		108	72									
2845					108	72				108	72				
2852			108	108								108			
2856		108	108		108										
2859				108				72				72		144	
2860							72	72							
2915			108		72	72						108			
2916			108		108	72								60	
2922		108	108			72								72	
3106	108					72		72	56		0		72		
3120					108	72							72		
3141			108	0			72								
3153			108		108	72				0					
3165		108					72								
3171		108													
3225		108	108				72			0	51				
3250	108							72			72				
3271	108								72				72		
3276	108								72				72	72	
3283	108				108			72	72				72		
3285	108							72	72				72		
3293	85	108				72			72				72		
3307			108		108	72				O	O		54		
9999	108								72						
Total # Parental Clones	8	9	10	4	10	10	5	8	7	4	5	5	8	4	
Total # progeny	841	752	1080	324	1044	720	360	576	488	108	197	435	558	348	7831

Table 5. Intercrossing 'Disease Resistant' Parental Lines with 'susceptible' parents to define progeny performance and heritability of disease resistance. Reciprocal crosses were made in all cases.

	Susceptible Parents		
Resistant Parents	2784	3285	Total Progeny
2859	18/6	72/72	168
2916	72/72	72/72	288
2922	72/72	72/72	288
3276	72/72	72/72	288
Total Progeny	456	576	1032

Table 6. Other Single crosses made during 1990. HT accessions were obtained from Penncross progeny which were selected for superior heat tolerance and cycled to Dr. Bill Meyer, Pureseed Testing, Hubbard Oregon in 1989.

	Parental Lines (Male)					
Parental Lines (Female)	3120	3250	HT57-1	HT57-9	HT57-13	# Progeny
3120	-	72	0	12	24	108
3250	0	-	72	0	4	76
HT57-1	32	0				32
HT57-9	0	2				2
HT57-13	48	72				120
# progeny Available for Evaluation and Reselection	80	146	72	12	28	338

APPENDIX A

Syn1-88

ATTACHMENT C
Petition to Release

PLANT MATERIALS RELEASE PROPOSAL

Date 10 October 1990

1. CROP **Bentgrass** Type of Release **Varietal**

2. Proposed name or identification: [redacted]

3. Designation or name in development stages: **Syn1-88 or TAMU Syn88-1**

4. **Primary features or advantages:** Syn1-88 is a nine clone synthetic, selected for its superior quality, density of turf and general performance for bentgrass greens in southern regions of the Transition zone for turfgrasses. The variety has a broad genetic base as a product of selecting strictly within the germplasm base of Seaside Creeping Bentgrass. Seaside, a landrace variety originating along the sea coast of Oregon has excellent seed production and a broad area of adaptability; however, the variety generally lacked in heat tolerance, density and consistency of turf quality. Syn1-88 is a third cycle reselection of Seaside with specific selection for deep and persistent rooting, improved heat tolerance, and improved turf quality and stability. Data supports superior summer performance compared to Penncross, or Pennlinks creeping bentgrasses (industry standards) which are the principle proprietary creeping bentgrass varieties presently in use in the same area.

Syn1-88 ranked the highest in turfgrass performance more consistently than seven commercial cultivars in the same trials at TAES-Dallas. Its performance at Augusta National Golf Course, Augusta, Georgia from October 1988 through May 1990 (Figures 1 and 2). and in West Palm Beach Florida is similar to Penncross (Table 11).

5. **Plant Variety Protection - suggested action:** Certification required, process for Plant Variety Protection. Plant material will be transplanted to Seed Production Nursery, Oregon in fall 1990 with the initial (Yr-1) PVPA data submitted in the fall 1991, and the final data in the fall 1992.

6. **Seed -- amount available and date:** Approximately 35 pounds available as of 10 October 1990.

7. **Provisions to maintain breeder seed:** Prebreeder/Breeder fields established in Oregon in 1989 yield limited quantity of seed. Due to grower contracts, it will be necessary to vegetatively reestablish breeder field in 1990. Sufficient breeder seed is available to establish Foundation production in the spring of 1991.

8. **Proposed seed distribution:** To Foundation Seed Service (FSS) for spring 1991 increase of 10+ acres of Breeder/Foundation Stock and license to single company for marketing, production, and distribution.

9. **Suggested Fees (for Breeder or Genetic Stock):** $20,000 + License

10. **Supportive documents attached:**

Release proposal XXXX Draft Misc. Pub. ____ Draft Variety Leaflet _____

11. **Release Proposal - prepared with or reviewed by:** Dr. V. G. Lehman, Dr. Richard White, Dr. Bridget Ruemmele, Dr. James A. Reinert.

12. **Suggested Reviewers: In Texas and U.S. (Names and Locations):**

Dr. James Read - TAES- Dallas
Dr. Victor Gibeault - California
Dr. Terrance Riordan - Nebraska
Dr. Michael P. Kenna - Oklahoma

Submitted by:

Breeder and Scientists-

M. C. Engelke _____
V. G. Lehman _____

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James A. Reinert _____

Authorship and % Contribution by each:

V. G. Lehman (____%) _____
Plant Breeder, Lofts Corporation, Formerly Research Associate, TAES-Dallas

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Associate Professor, TAES-Dallas

R. C. Shearman (____%) _____
Head, Department of Agronomy, University of Nebraska, Lincoln, Formerly Professor Turf Physiology

Syn1-88 Creeping Bentgrass[1]

V. G. Lehman, M. C. Engelke and R. C. Shearman[2]

'Syn1-88' creeping bentgrass (Agrostis stolonifera subsp. palustris Huds.) was developed and released by the Texas Agricultural Experiment Station in 1990. Syn1-88 will be suitable for use as a cool-season turfgrass for putting surfaces and fairways throughout the usual area of adaptation of creeping bentgrass, with improved adaptation to the Southern Transition zone. Syn1-88 was developed as a synthetic variety from a replicated nursery of nine maternal clones established in Tangent, OR in 1987, and designated as Syn1-88. The maternal clones designated as 1007A, 604B, 605B, 203A, 604A, 1004A, 706A, 902A, and 606B were selected from an original population consisting of 294 bentgrasses, all originating from the cultivar 'Seaside'. A breeder field was established from seedlings of Syn1-88 (Generation 1). The breeder field will produce the Foundation Class (Generation 2) which will be used to produce Registered or Certified Class (Generation 3), either of which will be the market class. Foundation fields are limited to 3 years production, after which they may be downgraded to certified for 3 years production. Certified production is limited to no more than 7 years from date of planting.

'Seaside' creeping bentgrass is a heterogenous population, widely regarded as equivalent to a land race cultivar. Seaside, released in 1923, is still requested for use as a cultivar because of its documented salinity tolerance; tolerance to lower intensity of culture, excellent tolerance to winter desiccation, and good spring green-up. An improved cultivar derived from Seaside with improvements in it known segregation into off-color, coarse type plants with retention of positive characters would contribute significantly to the turf industry, Consequently, a breeding effort was directed towards production of a cultivar with retention of the positive qualities of Seaside, with improvements in the negative characters.

In April 1985, approximately 10,000 seedlings of Seaside creeping bentgrass were established in a greenhouse bench constructed to manipulate soil temperature. Subjected to 40°C soil temperatures (10 cm depth) at 6 weeks of age, 196 plants survived for 21 to 28 days, and were respectively designated as Seaside-RHT clones. The survivors (RHT population) were vegetatively propagated and maintained in the greenhouse. RHT (n=196) was

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[1]Syn1-88 was developed the by Texas Agricultural Experiment Station with partial funding from the United States Golf Association and Bentgrass Research, Inc.

[2]Turfgrass Breeder, Lofts Great Western Seed Company, Albany, OR (former Research Associate, TAES-Dallas); Associate Professor, Texas A&M Research and Extension Center, Dallas, Texas, and Head, Department of Agronomy, University of Nebraska - Lincoln (former Professor, Turfgrass Physiology).

compared for morphological and physiological attributes with an unselected Seaside population (n=98) in greenhouse studies conducted in 1986-1988 (Table 1). The mean maximum root extension obtained for the RHT population, using flexible tube minirhizotrons was significantly longer than Seaside. As a population, Seaside-RHT had a mean 2.3 cm increase in maximum root extension (Table 1), consistent with improved dehydration avoidance. The number of tillers per plant were significantly higher (density) for the RHT population. No differences were detected for average shoot weight between populations; however, the RHT population contained 10% more water per gram of dry tissue than original Seaside (Table 1), suggesting the potential to continue transpirational cooling under summer stress conditions.

Specific information on the nine parental clones comprising Syn1-88 is presented in comparison to the mean of Syn1-88 clones, all Seaside accessions studied, including RHT, and 'Penncross' (Table 2). The average number of tillers for the nine parental clones (16.5) was 20% higher than the average of all Seaside accessions, and similar to Penncross (17.2). The leaf blade width of Syn1-88 clones averaged 12% narrower than Seaside (1.44 mm) and 16 % narrower than Penncross (1.5 mm). Root extension, using the flexible tube minirhizotrons was determined on 70 of the Seaside and RHT clones. Of these, the five parental clones in Syn1-88 averaged 48.1 cm in length compared with 135 clones from Seaside and RHT which averaged 41.5 cm. This represents a 16% deeper root than present for Seaside.

A total of 294 clones of Seaside and Seaside-RHT clones were evaluated for turf quality in 1986-1987 on a sand green with management as a putting green, with the nine selected clones exhibiting a range in quality (Table 3). The quality selection differential was 25-56% higher for the parental clones of Syn1-88 than Seaside, depending on date of evaluation.

The nine clones of Syn1-88 were planted in Tangent, OR in 1987 in a replicated polycross nursery and allowed to interpollinate. Seed was harvested and cleaned in bulk from the polycross nursery, and used to establish preliminary putting green turf evaluation trials at Augusta, GA and Dallas, TX in the fall of 1988. A seeding rate of 49 g are^{-1} was used at both sites. Syn1-88 was planted in comparison with nine and seven commercial varieties and two additional TAES experimental varieties at Dallas and Augusta, respectively. Data from the other experimental varieties has been omitted from subsequent tables to prevent complications with disclosure prior to their release. Syn1-88 was superior to Seaside in initial establishment rate, but attained a similar percent stand within two months of establishment to both Seaside and Penncross. (Table 4).

Quality was visually rated on a 1 to 9 scale, with 9=best in the turf evaluations. The accumulated performance of each entry is reflected in a parameter identified as Phenotypic Stability (PS).

PS is defined as the frequency or the number of times the entry performed in the highest (best) statistical grouping regardless of the character measured. Syn1-88 had the highest phenotypic stability when evaluated in Dallas by non-Texas A&M affiliated evaluators (Table 5). These non-affiliated evaluators included golf professionals, golf course superintendents, seed salesmen, seed producers, and two other turf scientists. The improvement in performance of Syn1-88 in comparison to Seaside suggests a positive genetic shift had been effected for turf performance. When evaluated by Texas A&M researchers in Dallas from January 1989 through May 1990, Syn1-88 (PS=10) was consistently equal to or superior to Penncross (PS=7), and always superior to Seaside (PS=1) in quality performance. Comparing performance during the environmentally stressful months of July, August and September (1989), quality was 4.3, 5.9 and 7.1 for Syn1-88;, 2.5, 3.1 and 4.1 for Seaside, and 4.0, 3.3 and 4.5 for Penncross (Table 6).

During the summer stress periods, Seaside and Penncross declined in quality, while Syn1-88 retained a stable performance (Figure 1) with mowing at 0.3 cm and twice weekly treatments with a traffic machine. Syn1-88 was selected specifically for summer stress resistance with improved canopy resistance and root extension. Evaluation by the USGA research team in Dallas, 1989 indicated Syn1-88 to be higher in quality than Penncross and Seaside (Table 7). March 1990 tiller number from the turf plots in Dallas indicated Syn1-88 was significantly higher than Seaside but not different from Penncross (Table 8). Leaf blade width was significantly wider than SR1020, but not different from Penncross or Seaside (Table 8).

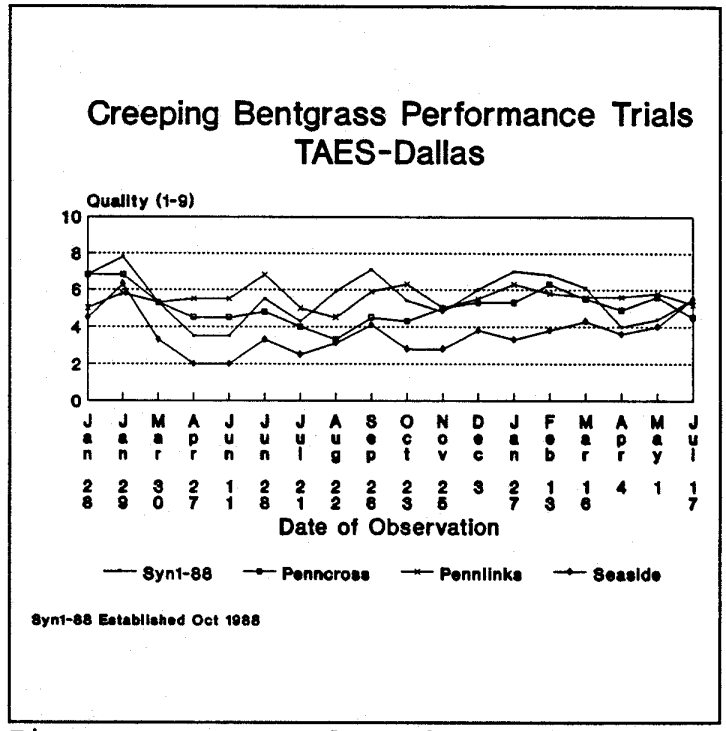

Figure 1. Seasonal performance of Syn1-88 at TAES-Dallas January 1989 through July 1990.

University of Georgia Extension staff indicated a mean quality for Syn1-88 not different from Penncross in 1989 (Table 9, Figure 2) and similar plant densities. Root extension of Syn1-88 was improved at Georgia over Seaside (Table 10), with no significant

difference in thatch accumulation.

Syn1-88 was entered into the National Turfgrass Evaluation Program (NTEP) with planting at 15 locations across the United States (Figure 3). The southern most planting of the Bentgrass NTEP was at Banyan Country Club, Florida in November 1989. Syn1-88 was not different from Penncross in quality or combined dollar spot or pythium resistance as observed in March 1990 (Table 11).

As with Penncross, Syn1-88 is susceptible to Helminthosporium leafspot. Syn1-88 has exhibited slight to moderate susceptibility to rust, Puccinia spp. in Oregon seed production fields. Syn1-88 was also entered into the NTEP fairway trials planted in October 1989 at approximately 20 locations across the United States. Information will be forth coming on its performance as these trials are generally scheduled to last 3 to 5 years at each location.

Syn1-88 is proposed for release as a broadly adaptable creeping bentgrass cultivar, similar in adaptation to its parent, Seaside, but with major improvements, in turf quality, as illustrated herein. Syn1-88 breeders seed will be available in Spring 1991.

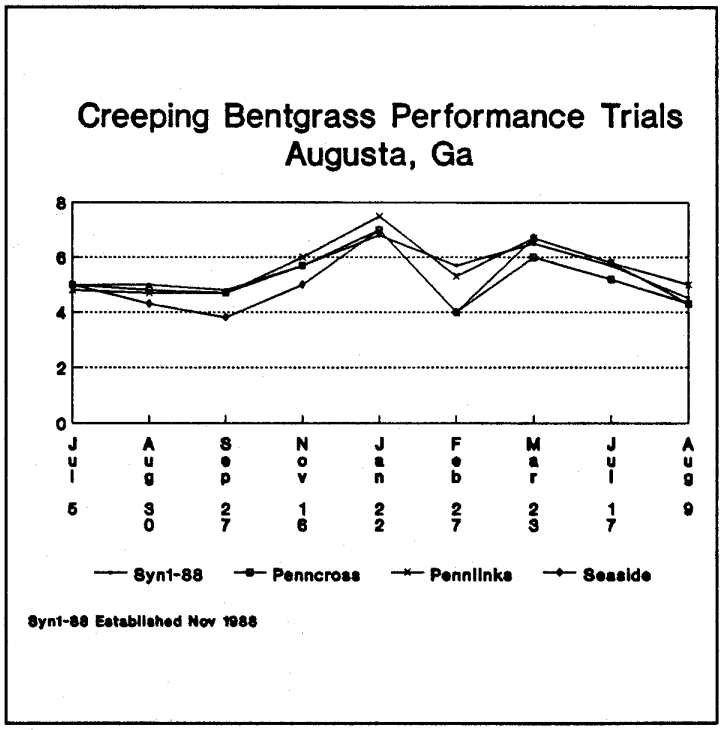

Figure 2. Seasonal performance of Syn1-88 at Augusta, Ga. from July 1989 through August 1990.

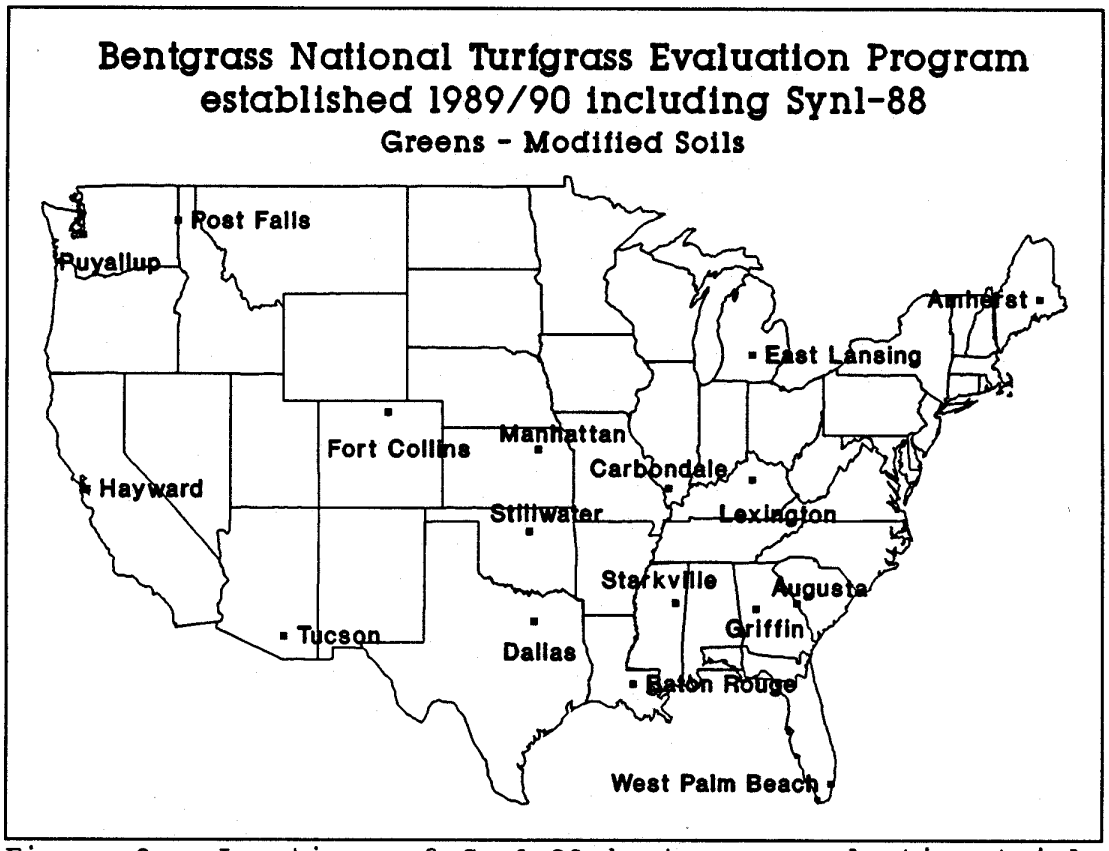

Figure 3. Locations of Syn1-88 bentgrass evaluation trials established in 1989/90 in conjunction with the National Turf Evaluation Program.

Table 1. Population means of shoot and root characters of Seaside and Seaside-RHT creeping bentgrass examined in flexible tubes.

Population	Maximum Root Extension cm plant^{-1}	Tiller # plant^{-1}	Shoot Weight mg plant^{-1}	Shoot Tissue Dry Weight ---%---
Seaside-RHT	42.6 a[1]	23.1 a	25.7 a	53.7 b[2]
Seaside	40.3 b	19.3 b	24.8 a	55.7 a

[1]F protected LSD. Means followed by the same letter are not significantly different ($p = 0.05$).
[2]Mean population values are significantly different using least-squares means ($p = 0.05$).

Table 2. Mean root extension, tiller number, and leaf blade width of the 9 parental clones of Syn1-88.

Clone	Tiller[1] --no.--	Root Extension[2] ------cm------	Leaf Blade Width[3] -------mm------
1007A	18.5	49.0	1.25
604B	17.0	.	1.08
605B	17.0	.	1.12
203A	13.0	46.3	1.43
604A	17.5	41.0	1.16
1004A	13.0	.	1.19
706A	12.0	54.5	1.70
902A	23.0	49.7	0.94
606B	17.5	.	1.51
Mean Syn1-88 (9 clones)	16.5	48.1	1.27
Mean 290 Seaside accessions	13.7	41.5	1.44
Selection Differential[4]	20%	16%	12%
Penncross	17.2	-	1.50
Range	7.5-23.0	27.9-58.2	0.9-1.6

[1]Measured as rooted tillers from 0.6 dia. cm cores harvested from field plots. Dallas, TX, 1987, with mowing at 0.6 cm.
[2]Measured in greenhouse flexible tubes in 1987.
[3]Measured as widest point of leaf blade from 3rd youngest leaf, mean of 3 leaves per plant, in 2 replications.
[4]Selection differential calculated as the proportionate change of the unselected to the selected.

Table 3. Mean quality of the nine parental clones of Syn1-88 at Dallas, TX, 1986-1987 mowed at 0.6 cm.

	DATE			
	1986			
Clone	30 May	9 Sept	30 Oct	10 Dec
	Quality (1 - 9, 9 = best)			
1007A	7.0	7.0	7.5	5.5
604B	4.0	6.5	6.0	7.8
605B	5.5	7.0	8.0	8.0
203A	6.0	7.0	7.5	8.5
604A	7.0	7.0	8.0	7.5
1004A	6.0	7.5	7.5	7.5
706A	7.0	5.0	7.5	8.0
902A	7.0	8.0	7.5	8.5
606B	3.0	7.5	8.0	8.3
Mean Syn1-88 clones	5.8	6.9	7.5	7.7
Mean 294 Seaside accessions	4.6	5.2	4.8	5.2
Selection Differential	26%	32%	56%	48%
Range	2.0-8.0	1.0-9.0	1.0-8.0	2.0-8.5

Table 4. Percent stand of Syn1-88 and nine cultivars of creeping bentgrass. Seed of each was planted at a rate of 49 g are^{-1} on 31 October 1988 in a randomized complete block design with four replications.[1]

	YEAR				
Variety	1988				1989
	9 Nov.	5 Dec.	19 Dec.	26 Dec.	3 Jan.
	Percent Stand				
Syn1-88	13.8 ab[2]	22.5 b	18.8 b	28.8 ab	62.5 b
National	23.7 ab	33.8 a	28.8 a	35.0 a	80.0 a
SR1019	11.0 bc	6.5 de	13.8 bcd	21.3 b-e	46.3 cd
Putter	8.8 bc	9.3 cde	13.8 bcd	22.5 bcd	55.0 bc
Penncross	8.0 bc	16.3 bc	19.3 b	27.5 ab	57.5 bc
Cobra	5.3 bc	5.5 de	10.5 cde	16.3 def	45.0 cd
SR1020	4.3 bc	8.0 de	12.5 cd	13.8 ef	40.0 de
PSU-126	3.3 c	5.3 de	8.8 de	13.8 ef	30.0 e
Southshore	3.0 c	3.5 de	11.0 cde	12.5 f	35.0 de
Seaside	1.0 c	10.0 cd	14.5 bc	26.3 bc	57.5 bc

[1]Partial data set, complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k=100.

Table 5. Quality ratings of Syn1-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989, by independent evaluators.[1]

	Evaluator/Date								
	SG	RH	RH	SO	RW	DH	SM	WT	MM
Variety	3-1	3-29	3-30	4-3	4-4	4-7	5-31	6-20	6-20
	Quality (1-9, 9=best)								
Syn1-88	7.3 a[2]	5.3 ab	5.3 de	5.6 ab	6.5 abc	6.0 cd	3.8 de	7.2 a	6.0 e
Penncross	6.8 a	5.8 ab	6.3 bcd	5.9 a	6.0 abc	6.8 abc	5.0 cd	7.3 a	6.4 cde
SR1019	4.5 cd	6.0 ab	6.8 ab	5.3 ab	6.3 abc	7.0 abc	7.3 ab	7.2 a	7.1 a-d
SR1020	6.0 ab	5.5 abc	6.3 bcd	5.8 ab	5.8 bcd	7.5 ab	7.8 ab	7.5 a	7.3 abc
PSU126	3.5 de	5.0 bc	5.5 cde	4.8 ab	5.0 cde	6.5 abc	6.3 bc	7.1 a	7.4 ab
National	5.0 bc	3.3 d	4.0 f	5.0 ab	4.3 de	6.0 cd	4.5 d	7.4 a	4.9 f
Cobra	4.3 cd	5.0 bc	5.3 de	5.0 ab	5.3 cde	6.8 abc	6.3 bc	7.7 a	6.8 b-e
Southshore	4.0 cd	5.0 bc	6.5 abc	5.4 ab	5.8 bcd	6.3 bc	4.5 d	7.3 a	6.3 de
Seaside	3.5 de	3.5 d	4.0 f	4.6 ab	3.8 e	6.5 abc	2.8 ef	7.0 a	4.5 f
Putter	2.3 e	4.3 cd	5.0 ef	4.3 b	1.0 f	4.8 d	2.0 f	7.3 a	7.8 a

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan multiple comparison procedure (K ratio = 100). Quality rated 1-9, with 9 = best.

Table 5 (cont). Quality ratings of Syn1-88 and nine cultivars of creeping bentgrass, TAES-Dallas 1989, by independent evaluators.

	Evaluator/Date										Phenotypic[3]
	PM	DN	TD	BC	KS	DD	SS	JB	WB	MS	Stability
Variety	7-12	7-12	8-27	9-8	9-8	9-8	9-8	10-4	10-4	10-4	--#(19 max)--
	Quality (1-9, 9=best)										
Syn1-88	5.1 def[2]	5.5 d	4.3 abc	8.3 ab	8.3 ab	8.0 a	8.3 a	7.8 a	6.8 a	7.8 a	15
Penncross	4.9 ef	5.5 d	4.3 abc	8.0 ab	8.0 ab	7.0 a	7.3 a	5.5 b-e	4.5 abc	6.0 abc	13
SR1019	5.6 cde	6.5 c	3.5 bcd	8.3 ab	8.3 ab	7.0 a	7.5 a	4.5 cde	2.8 bc	5.8 abc	13
SR1020	6.3 abc	7.0 bc	2.8 d	8.5 a	8.5 a	7.8 a	7.5 a	4.0 de	1.8 c	4.5 c	12
PSU 126	6.0 a-d	6.8 c	3.8 a-d	8.0 ab	8.0 ab	7.5 a	7.0 a	5.8 bcd	4.3 abc	6.3 abc	12
National	5.1 def	4.8 de	4.8 ab	8.0 ab	8.0 ab	8.0 a	8.5 a	7.3 ab	6.5 a	7.3 ab	10
Cobra	4.9 ef	5.5 d	3.8 a-d	8.3 ab	8.3 ab	7.3 a	7.3 a	5.3 cde	4.3 abc	5.5 bc	9
Southshore	5.8 b-e	5.5 d	4.3 abc	7.3 b	7.3 b	7.3 a	7.3 a	5.5 b-e	3.8 abc	5.8 abc	8
Seaside	3.0 g	4.3 e	5.0 a	7.3 b	7.3 b	7.0 a	7.8 a	6.0 abc	5.3 ab	7.0 ab	9
Putter	4.3 g	6.8 c	3.3 cd	8.5 a	8.5 a	8.0 a	8.3 a	5.5 b-e	4.0 abc	6.8 ab	8

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k = 100. Quality rated 1-9, with 9 = best.
[3]Phenotypic Stability = number of occurrences a genotype was in top quality group for each date.

Table 6. Quality ratings of Syn1-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989, by TAES researchers.[1]

Cultivar	Date - 1989								
	28 Jan	29 Jan	30 Mar	27 Apr	11 Jun	28 Jun	21 Jul	22 Aug	26 Sept
	Quality (1-9, 9=best)								
Syn1-88	6.8 a[2]	7.8 a	5.3 bcd	3.5 ef	3.5 ef	5.5 de	4.3 de	5.9 ab	7.1 a
Penncross	6.8 a	6.8 a	5.3 bcd	4.5 de	4.5 de	4.8 ef	4.0 e	3.3 c-e	4.5 bcd
SR1019	6.0 ab	7.3 a	5.5 bc	6.0 bc	6.0 bc	7.8 ab	5.5 bc	5.8 ab	5.4 a-d
SR1020	5.0 b	6.3 ab	5.8 ab	7.0 ab	7.0 ab	8.3 a	6.3 ab	5.0 a-d	4.8 bcd
PSU126	5.0 bc	5.8 ab	5.3 b-d	5.5 cd	5.5 cd	6.8 bc	5.0 cd	4.5 b-e	5.9 abc
National	4.8 bc	6.0 ab	3.5 de	3.0 fg	3.0 fg	3.5 gh	3.5 e	4.8 a-e	5.9 abc
Cobra	4.5 bc	6.3 ab	5.3 bcd	5.3 cd	5.3 cd	6.0 cd	5.0 cd	4.9 a-e	5.6 a-d
Southshore	4.5 bc	6.0 ab	5.3 bcd	4.5 de	4.5 de	4.3 fgh	4.0 e	2.8 e	3.5 d
Seaside	4.5 bc	6.3 ab	3.3 e	2.0 g	2.0 g	3.3 h	2.5 f	3.1 de	4.1 cd
Putter	3.5 c	4.5 b	3.8 cde	3.5 ef	3.5 ef	4.5 efg	5.3 c	5.4 abc	5.3 a-d

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k = 100. Quality rated 1-9, with 9 = best.

Table 6 (cont.) Quality ratings of Syn1-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989-1990, by TAES researchers.[1]

Cultivar	Date								Phenotypic[3] Stability
	1989			1990					
	23 Oct	25 Nov	3 Dec	27 Jan	13 Feb	16 Mar	4 Apr	1 May	--#(17 Max)--
	Quality (1-9, 9=best)								
Syn1-88	5.4 a-d[2]	4.8 abc	6.0 a	7.0 ab	6.8 a	6.1 ab	4.0 bc	4.4 cd	10
Penncross	4.3 cde	5.0 abc	5.3 a	5.3 bc	6.3 a	5.5 abc	4.9 abc	5.6 a-d	7
SR1019	5.0 bcd	5.8 ab	6.0 a	6.3 abc	6.8 a	7.0 ab	6.5 a	7.1 a	11
SR1020	5.5 abc	5.3 ab	4.0 a	6.0 abc	6.8 a	5.0 abc	5.9 ab	6.1 a-d	13
PSU126	6.3 ab	5.0 abc	5.5 a	6.3 abc	5.8 ab	5.6 abc	5.6 abc	5.8 a-d	9
National	4.0 cde	3.5 c	4.8 a	5.5 bc	4.3 bc	3.5 c	3.6 c	3.9 d	3
Cobra	4.3 cde	4.8 abc	5.8 a	5.0 cd	5.8 ab	4.8 abc	5.8 ab	4.5 bcd	7
Southshore	3.8 de	4.5 abc	4.0 a	5.0 cd	6.3 a	5.4 abc	4.4 bc	4.6 bcd	3
Seaside	2.8 e	2.8 c	3.8 a	3.3 d	3.8 c	4.3 bc	3.6 c	4.0 cd	1
Putter	6.1 ab	5.8 ab	6.5 a	7.5 a	7.0 a	6.1 ab	5.4 abc	6.9 ab	9

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test, where k = 100. Quality rated 1-9, with 9 = best.
[3]Phenotypic stability = number of occurrences a genotype was in top quality group for each date.

Table 7. Mean quality ratings of Syn4-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989, by 22 participants in the USGA summer research meetings[1].

Cultivar	Quality rating (1-9, 9=best)
Syn1-88	5.8 bc[2]
Penncross	5.1 ef
SR1019	4.8 f
SR1020	5.6 cd
PSU126	5.4 de
National	5.3 de
Cobra	5.4 de
Southshore	5.1 ef
Seaside	3.9 g
Putter	6.0 b

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k = 100. Quality rated 1-9, with 9 = best.

Table 8. Tiller number per core and leaf blade width of nine cultivars and Syn1-88 harvested from Dallas, TX in Oct. 1989 and March 1990.[1]

	Tiller		Leaf Blade Width	
	Date		Date	
Cultivar	Oct. 1989	March 1990	Oct. 1989	March 1990
	----------no.---------		----------mm---------	
Syn1-88	17.0 cde[2]	39.2 de	0.87 ns[3]	1.03 a
Pennlinks	21.7 ab	47.3 abc	0.87	1.02 ab
SR1019	19.8 bc	51.3 a	0.90	0.93 ab
Putter	18.7 bcd	45.2 c	0.87	0.91 ab
SR1020	18.7 bcd	51.7 a	0.81	0.90 b
Cobra	17.2 cde	38.8 def	0.89	0.91 ab
Penncross	16.7 cde	38.7 def	0.85	0.98 ab
National	16.4 de	34.5 ef	0.90	0.96 ab
Seaside	15.0 e	28.6 g	0.91	1.03 ab
Southshore	14.1 e	33.5 fg	0.85	1.01 ab

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test where k = 100.
[3]Means are not significantly different using least square means F test.

Table 9. Mean quality ratings of Syn1-88 and seven cultivars of creeping bentgrass, Augusta, GA, 1989 and 1990.[1]

Cultivar	DATE									Phenotypic Stability[4] --#(7 Max)--
	5 July	30 Aug.	27 Sept.	16 Nov	22 Jan	27 Feb	23 Mar	17 Jul[3]	9 Aug[3]	
	Quality (1-9, 9=best)									
Syn1-88	5.0 de[2]	5.0 bcd	4.8 cd	5.7 cd	6.8 ns	5.7 bc	6.5 c	???	???	0
Penncross	5.0 de	4.8 bcd	4.7 cd	5.7 cd	7.0	4.0 e	6.0 c	5.2	4.3	1
SR1019	6.3 bc	5.5 bc	5.0 bc	5.7 cd	7.3	7.3 ab	7.5 ab	5.8	5.0	3
SR1020	7.5 a	5.7 b	5.5 ab	7.7 ab	7.7	7.7 a	7.2 abc	6.0	5.0	6
Pennlinks	4.8 e	4.7 cd	4.7 cd	6.0 cd	7.5	5.3 cde	6.7 bc	5.8	5.0	1
Cobra	4.8 e	4.8 bcd	4.3 de	5.7 cd	7.0	4.3 e	6.2 c	5.7	4.2	1
Seaside	5.0 de	4.3 d	3.8 e	5.0 d	7.0	4.0 e	6.7 bc	5.8	4.3	1
Putter	5.8 cd	4.3 d	4.5 cd	7.7 ab	7.2	5.3 cde	7.7 ab	5.7	4.5	3

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test, where k = 100. ns=nonsignificant.
[3]Data not analyzed
[4]Phenotypic Stability

Table 10. Density of stand, thatch accumulation, and root length of Syn1-88 and seven bentgrass cultivars at Augusta, GA during 1989-90.[1]

Cultivar	Density[2]	Thatch[3]	Length[3]
		--cm--	-cm x 10-
Syn1-88	4.7 c[4]	0.47 ns	3.5 a
Putter	4.2 cd	0.37	2.7 ab
SR1019	4.8 c	0.47	2.9 ab
SR1020	5.7 b	0.50	3.0 ab
Seaside	3.7 d	0.45	2.2 b
Pennlinks	4.8 c	0.43	2.6 ab
Cobra	4.2 cd	0.47	3.3 a
Penncross	4.2 cd	0.43	2.9 ab

[1]Partial data set; complete data set includes two additional experimentals.
[2]Density ratings 1 to 9, 9 = highest. Notes taken 27 Sept. 1989.
[3]Thatch and root length measured on 16 Nov. 1989.
[4]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test where k = 100. ns = nonsignificant.

Table 11. Quality and disease evaluation of Syn4-88 and cultivars entered into the National Turfgrass Evaluation Program planted at Banyan Country Club, West Palm Beach, Florida during 1990.[1]

Variety	Date		Disease[3]
	16 Jan.	1 Mar.	
	-- Quality (1-9, 9=best) --		
Syn1-88	4.7 cde[2]	5.3 c-g	5.3 c-g
UM8401	7.7 a	7.7 ab	8.0 ab
Putter	7.3 ab	6.3 a-f	6.3 a-f
SR1020	7.0 abc	6.3 a-f	7.3 a-d
88.CBE	6.7 a-d	7.0 a-d	7.0 a-d
Forb89-12	6.3 a-c	6.7 a-e	7.0 a-d
88.CBL	6.3 a-d	6.0 a-f	5.7 b-g
WVPB89D15	6.0 a-e	7.3 abc	6.7 a-e
Carmen	6.0 a-e	5.3 c-g	6.3 a-f
MSCB-8	5.7 a-e	5.3 c-g	5.7 b-f
MSCB-6	5.3 a-e	4.7 efg	5.3 c-g
Cobra	5.3 a-e	5.0 d-g	5.3 c-g
Penncross	5.3 a-e	6.0 a-f	5.3 c-g
Tracenta	5.3 a-e	4.7 efg	6.3 a-f
National	5.0 b-e	5.7 b-g	5.3 c-g
Pennlinks	5.0 b-e	6.3 a-f	5.7 b-g
Allure	4.7 cde	4.7 efg	5.0 d-g
Providence	4.7 cde	6.7 a-e	4.3 e-h
Bardot	4.3 def	4.7 efg	5.0 d-g
Emerald	3.7 ef	5.0 d-g	4.0 fgh
Egmont	3.7 ef	4.3 fg	3.7 gh
BR1518	2.0 f	3.7 g	2.3 h

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test where k = 100. ns = nonsignificant.
[3]Combined dollar spot and pythium damage, rating 1-9, where 9=no damage.

APPENDIX B

Syn3-88

ATTACHMENT C
Petition to Release

PLANT MATERIALS RELEASE PROPOSAL

Date 31 July 1990

1. CROP **Bentgrass** Type of Release **Varietal**
2. Proposed name or identification:

3. Designation or name in development stages: **Syn3-88 or TAMU Syn88-3**

4. Primary features or advantages: Syn3-88 is a six clone synthetic, selected for its superior quality, density of turf and general performance for bentgrass greens in southern regions of the Transition zone for turfgrasses. The variety has higher density, and more aggressive growth habits during summer months than Penncross, or Pennlinks creeping bentgrasses (industry standards) which are the principle proprietary creeping bentgrass varieties presently in use in the same area. Syn3-88 ranked the highest in turfgrass performance more consistently than seven commercial cultivars in the same trials at TAES-Dallas, and Augusta National Golf Course, Augusta, Georgia from October 1988 through May 1990 (Figures 1 and 2). Syn3-88 rated 8.3 (rating 1 to 9 with 9 = no pythium or dollar spot damage) in January 1990, superior to Pennlinks (5.7), or Penncross (5.3) (Table 15) in test at West Palm Beach, Florida.

5. Plant Variety Protection - suggested action: Certification required, process for Plant Variety Protection. Plant material will be transplanted to Seed Production Nursery, Oregon in fall 1990 with the initial (Yr-1) PVPA data submitted in the fall 1991, and the final data in the fall 1992.

6. Seed -- amount available and date: Approximately 100 pounds available 15 August 1990.

7. Provisions to maintain breeder seed: Prebreeder/Breeder fields established in Oregon in 1989 with initial seed harvest in 1990. Second crop will be harvested in August 1991 (ca. ~150 - 200 pounds) with proposal to place in cold storage facilities. Sufficient seed to establish 100 - 200 acres foundation or base planting stock.

8. Proposed seed distribution: To Foundation Seed Service (FSS) for fall 1990 increase of 10+ acres of Breeder/Foundation Stock and license to single company for marketing, production, and distribution.

9. Suggested Fees (for Breeder or Genetic Stock): $20,000 + License

10. Supportive documents attached:

Release proposal XXXX Draft Misc. Pub. _____ Draft Variety Leaflet _____
Memo of Agreement ____ Proposed Distribution List ____

11. Release Proposal - prepared with or reviewed by: Dr. V. G. Lehman, Dr. Richard White, Dr. Bridget Ruemmele, Dr. James A. Reinert.

12. Suggested Reviewers: In Texas and U.S. (Names and Locations):

Dr. James Read - TAES- Dallas
Dr. Victor Gibeault - California
Dr. Terrance Riordan - Nebraska
Dr. Michael P. Kenna - Oklahoma

Submitted by:

Breeder and Scientists-

M. C. Engelke _____

V. G. Lehman _____

Unit Head

James A. Reinert _____

Authorship and % Contribution by each:

M. C. Engelke (___%) _____
Associate Professor, TAES-Dallas

V. G. Lehman (____%) _____
Plant Breeder, Lofts Corporation, Formerly Research Associate, TAES-Dallas

W. R. Kneebone (___%)_____
Professor Emeritus (Arizona)

SYN3-88 CREEPING BENTGRASS[3]

M. C. Engelke, V. G. Lehman, and W. R. Kneebone[4]

'Syn3-88' creeping bentgrass (Agrostis stolonifera subsp. palustris Huds.) was developed for release by the Texas Agricultural Experiment Station in 1990. Syn3-88 will be suitable for use as a cool-season turfgrass for golf course putting surfaces and fairways throughout the usual area of adaptation of creeping bentgrass, with improved adaptation to the Southern transition zone. Syn3-88 is a six clone synthetic variety selected from an original 92 clone germplasm nursery.

Following extensive agronomic selection and evaluation at TAES-Dallas, a 50 clone elite germplasm nursery was established in Oregon in the fall of 1985 to evaluate seed production potential. Six parental clones, from these 50 genotypes, were selected based on floral niching and plant type in Tangent, Oregon during the 1986 and 1987 growing seasons. The parental clones were physically isolated in January 1988 in Oregon with the first seed harvest in August 1988 (Pre-breeder Seed). The parental clones, originating from Arizona and Texas, were designated as TAES-2737, TAES-2739, TAES-2740, TAES-2741, TAES-2743, and TAES-2895 (Table 1). A limited seed supply was germinated, with approximately 2000 seedlings established as transplants in a 0.13 ha. breeder/pre-breeder field in Oregon in January 1989. Additional roguing for uniformity of plant type and flowering date of the breeder field during 1989 and 1990 resulted in the breeder stock of Syn3-88 (Generation 1). Production fields of syn3-88 may be typified by having up to 20 percent of its inflorescence exhibiting an open panicle following pollination. Seed planted from this will provide planting stock to produce the Foundation Class (Generation 2), which in turn will be used to produce Registered or Certified Class (Generation 3). Either Registered or Certified will be used for the market class. Production from foundation fields should be limited to 3 years, after which the field may be downgraded to certified for an additional 3 years of production. Certified production will be limited to no more than 7 years from date of planting to ensure genetic purity and integrity.

The six parental clones of Syn3-88 were evaluated under greenhouse conditions for morphological characters in 1985 (Table 1). The parents had high density, an aggressive spread rating, and

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[3]Syn3-88 was developed by the Texas Agricultural Experiment Station with partial funding from the United States Golf Association and Bentgrass Research, Inc.

[4]Associate Professor, Texas A&M Research and Extension Center, Dallas, Texas; Turfgrass Breeder, Lofts Great Western Seed Co., Albany, OR (former Research Associate, TAES-Dallas), and Professor Emeritus, University of Arizona, respectively.

fine leaf type, with variable ligule lengths in comparison to the other 86 clones evaluated. Under field conditions, the parents were middle to higher in quality ratings (1986 through 1988) as compared to the other 86 clones of bentgrass (Tables 2 and 3).

Three of the six clones were lower than 'Penncross' in thatch accumulation as measured by thickness and weight of a 20 mm wide x 76 mm long slice of the thatch layer when evaluated in 1987 under greens management (Table 4). All six parents produced adequate seed germination and yield when grown in Tangent, OR in a polycross nursery containing 50 clones (Table 5). The parental clones were evaluated to determine date of heading (Table 6), with all clones initiating heading within 21 days of each other. Four of the six clones rated high in seedhead numbers when evaluated in Tangent, OR in 1987, with five of the six clones having an aggressive spread rating (Table 7).

Plants, measuring 25-30 cm in diameter with a 15 - 20 cm soil base were dug and transplanted into an isolated crossing block. The crossing block was composed of two replications of each clone randomly placed to enhance cross pollination. Seed was harvested by maternal clone and later bulked in equal quantities from each clone to create the variety designated 'Syn3-88'.

Turf plots were established at Augusta, GA and Dallas, TX under putting green management conditions in the fall of 1988 to compare Syn3-88 with nine commercial varieties, and two additional experimental varieties.
Data from the other experimental varieties have been omitted from subsequent tables to prevent complications with disclosure prior to their release. Seeding rate was 49 g are^{-1}. Syn3-88 was intermediate for stand establishment, but not significantly different from Penncross at Dallas in 1988 (Table 8). Quality was rated 1-9 with 9 = best in the turf evaluations. The accumulated performance of each entry is reflected in a parameter identified as Phenotypic Stability (PS). Phenotypic Stability is defined here as the frequency of the number of times the entry performed in the highest (best) statistical grouping regardless of the character measured. Syn3-88 and Penncross were similar in PS (14 of 19 observations) and higher than all other entries at Dallas when evaluated by 19 non-Texas A&M affiliated evaluators (Tables 9a, 9b). Outside evaluators included golf professionals, golf course superintendents, seed salesmen, seed producers, and two other turf scientists. When evaluated by Texas A&M researchers in Dallas, Syn3-88 ranked high (16 of 17) in phenotypic stability (Table 10) and was consistently superior to Penncross, 'Pennlinks' or 'Seaside' from January 1989 to the present (Figure 1).

When evaluated by 22 participants of the USGA 1989 summer research planning meetings, Syn3-88 had a mean quality of 5.7, in comparison with Penncross at 5.1 (Table 11). Syn3-88 had 19.3 and 49.7 tillers per 0.6 cm soil core, respectively, in October 1989 and March 1990 (Table 12), with significantly more than Penncross

in March. Leaf blade width was not significantly different from Penncross in October 1989 or March 1990 (Table 12).

Mean quality evaluations at Augusta, GA indicated that Syn3-88 was performing significantly better than Penncross, and was not different from the variety SR1020 (Table 13). The seasonal performance of Syn3-88 at Augusta was consistently superior to Penncross, Pennlinks and Seaside (Figure 2).

Syn3-88 was not different in thatch accumulation from the other varieties at Augusta, GA in 1989-90 (Table 14).

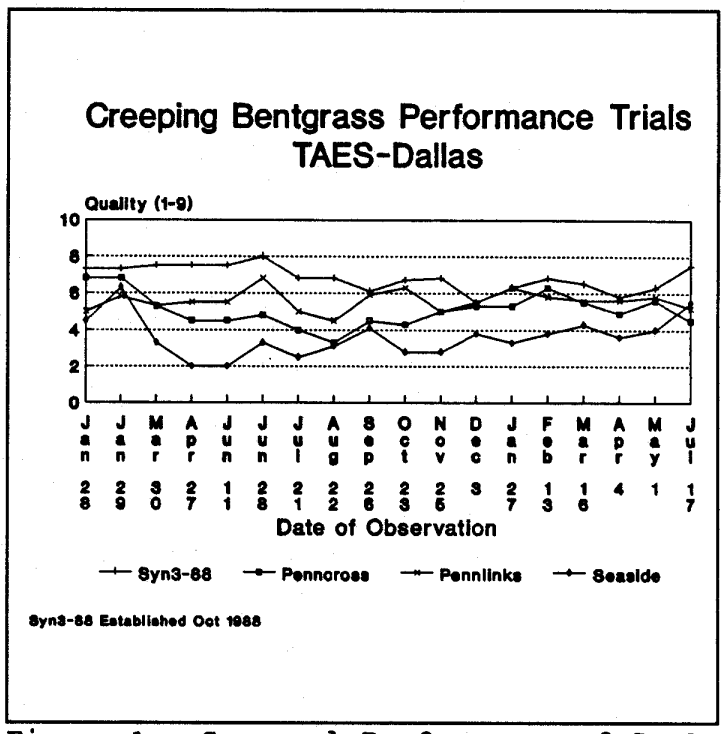

Figure 1. Seasonal Performance of Syn3-88 at TAES-Dallas January 1989 through July 1990.

Syn3-88 was planted in 1989 in Florida and Massachusetts in conjunction with the National Turfgrass Evaluation Program (NTEP). Syn3-88 will be planted at additional locations in 1990, including Arizona and Georgia. When evaluated at Banyan Country Club, West Palm Beach, FL. in the NTEP bentgrass trial during the spring of 1990, Syn3-88 was in the highest quality rating group and was not as susceptible to either Dollar spot (Sclerotinia spp.) and Pythium spp. disease as some other varieties (Table 15). Disease pressure at the West Palm Beach, Florida may be considered extreme due to high ambient temperatures and relative humidity.

Syn3-88 has been included in selected sites across the United States in conjunction with the Bentgrass national trials conducted through the national Turf Evaluation Program and the Maryland Turfgrass Council (Figure 3). These trials were established in 1989, but due to a lack of sufficient seed, it was necessary to plant Syn3088 at selected locations in 1989 and others in 1990. To date, all trials have been fully established.

Syn3-88 is genetically different from the other commercially available varieties, as illustrated by the performance data in this document. Breeder's seed is available as of August 1990. A 10 acre production field was established in Oregon to produce Foundation Class Seed in 1991.

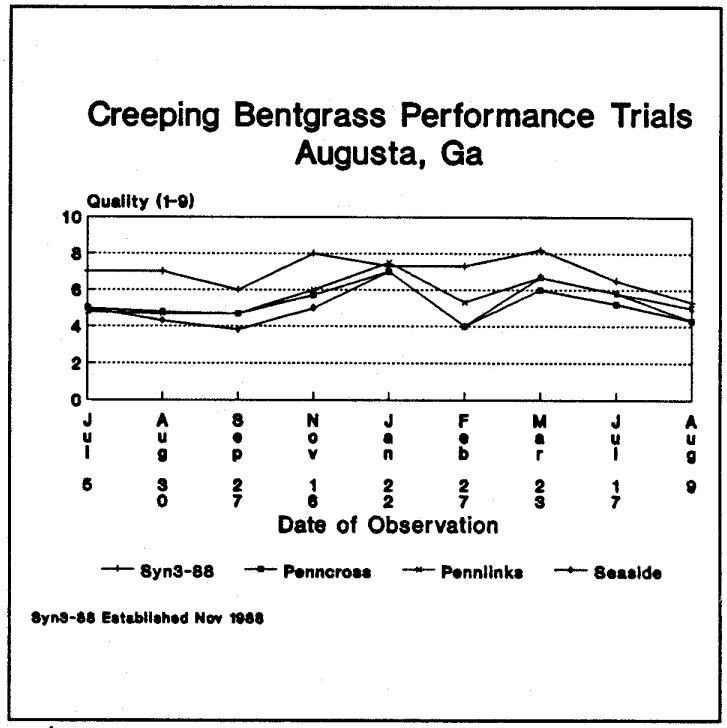

Figure 2. Seasonal performance of Syn3-88 at Augusta, Ga from July 1989 through August 1990.

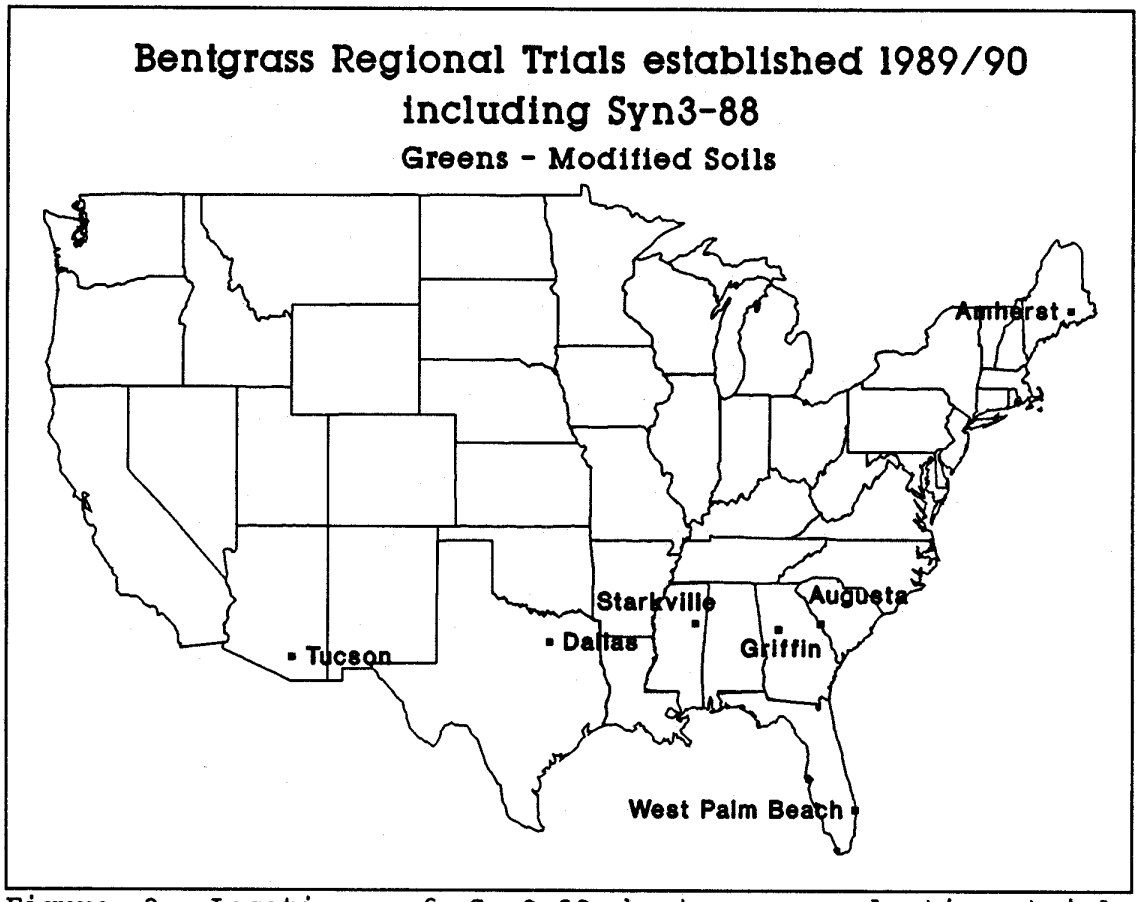

Figure 3. Locations of Syn3-88 bentgrass evaluation trials established in 1989/90.

Table 1. Greenhouse morphological characterization of parental clones of Syn3-88, taken 30 July 1985.[1]

Accession	Origin	Density	Growth Type	Spread	Spread Type	Leaf Width	Ligule Length
2737	Az	2	U	2	S	1.5	1.4
2739	Az	2	P	2	S	1.4	0.8
2740	Az	3	P	3	S	1.3	0.9
2741	Az	2	P	3	S	1.2	1.2
2743	Az						
2895	Tx	1	U	1	S	1.0	1.2

Non-replicated trial, but multiple measures per tray.
Density rated 1-3, 3=best.
Growth Type where P=prostrate, U=upright, I=Intermediate.
Spread rated 1-3, 3=most.
Type of spread, T=tillers, S=stolons.
Leaf width, mean of three leaf widths.
Ligule, means of three ligule lengths.

[1]Parental clone data extracted from analysis including all 92 clones.

Table 2. Mean quality of Syn3-88 parental clones under putting green conditions at TAES-Dallas in 1985 - 1986. [1]

		Quality						
	1985	1986						1986
Accession	085	016	069	111	146	175		Mean
2737	5.0 a-g[2]	7.5 abc	6.0 a-e	6.5 a-e	6.0 d-g	5.5 e-h		6.4 g-q
2739	2.0 g	6.5 a-e	3.0 e	5.0 c-h	5.0 f-i	6.0 d-g		5.7 p-z
2740	6.0 a-f	8.5 a	8.0 ab	8.0 ab	7.0 b-e	9.0 a		8.0 a
2741	5.5 a-g	6.0 a-f	5.5 a-e	6.5 a-e	7.0 b-e	9.0 a		6.9 d-n
2743								
2895	7.0 a-e	4.5 d-f	6.5 a-e	8.0 ab	6.5 c-f	6.5 d-g		6.5 f-s
Range	2.0-8.5	1.0-8.5	3.0-8.5	2.5-8.5	2.0-9.0	1.0-9.0		2.4-9.0
Penncross	-	-	-	5.5 b-g	7.0 b-e	8.0 b-d		-

[1]Parental clone data extracted from analysis including all 92 clones.
[2]Means followed by an 'a' were in the highest statistical grouping at the k=100 level using the Waller-Duncan k-ratio t test.

Table 3. Mean quality under putting green conditions at TAES-Dallas of Syn3-88 parental clones, 1987 - 1988. [1]

	Quality	
	1987	1988
Accession	Mean	Mean
2737	4.6 ab[2]	5.5 c-g
2739	4.0 ab	7.0 a-d
2740	6.4 ab	7.0 a-d
2741	4.2 ab	4.0 f-j
2743	5.0 ab	7.0 a-d
2895	4.0 ab	8.0 ab
Range	1.6-7.2	1.5-8.0
Penncross	5.3 ab	5.0 d-h

[1]Parental clone data extracted from analysis including all 92 clones.
[2]Means followed by the same letter are not significanlty different using the Waller-Duncan k ratio t test (k=100).

Table 4. Mean depth and weight of thatch layer of parental clones of Syn3-88 taken 17 June 1987 from a 20 mm by 77 mmm soil slice.[1]

Accession	Depth	Weight
	--mm--	--mg--
2737	8.0 ns	15.8 a[2]
2739	7.5	15.3 a
2740	7.5	15.3 a
2741	8.0	14.5
2743		
2895	6.8	14.8
Range	5.3-10.0	13.3-16.5
Penncross	7.8	15.0 a

[1]Parental clone data extracted from analysis including all 92 clones.
[2]Means followed by an 'a' were in the highest statistical grouping at the k=100 level using the Waller/Duncan k-ratio t test.

Table 5. Germination and seed yield of parental clones of Syn3-88 grown in Tangent, Oregon, 1986. [1]

Accession	Germination[2]	Seed yield[3]
	--Percent--	--g--
2737	91	2.10
2739	71	1.00
2740	72	1.20
2741	68	1.55
2743	76	1.75
2895	68	2.80
Range	50-91	0.0-6.83

[1]Parental clone data extracted from analysis including all 92 clones.
[2]3 petri plates of 100 seeds each counted after 7 days of hydration. One application of Subdue for Pythium spp. control.
[3]Mean seed yield per plant with 3 plants per treatment.

Table 6. Heading date of parental clones of Syn3-88 by replication, in Tangent, Oregon, in 1987.

Accession	Replication I	II	III
2737	6/18	6/25	6/16
2739	.	6/25	6/6
2740	6/4	6/6	6/5
2741	6/10	6/7	6/3
2743	6/16	6/13	6/12
2895	6/8	6/8	6/6

Table 7. Mean seedhead, spread rating, and growth habit (9=erect) of parental clones of Syn3-88 at Tangent, Oregon in 1987.

Accession	Seedhead	Spread	Growth habit
	Rating 1-9, 9=best		
2737	4.3[1]	7.7 a	3.0
2739	5.7	8.0 a	6.3 a
2740	8.3 a	6.3 a	3.3
2741	9.0 a	6.3 a	2.0
2743	8.3 a	7.0 a	2.7
2895	7.3 a	4.3	2.7
Range	0.0-9.0	1.7-9.0	1.0-8.3

[1]Means followed by an 'a' in the same column were in the highest statictical grouping at the k=100 level using Waller-Duncan k ratio t test.

Table 8. Percent stand and quality ratings of Syn3-88 and nine cultivars of creeping bentgrass. Seed of each was planted at a rate of 49 gm are^{-1} on 31 October 1988 in a randomized complete block design with four replications.[1]

Variety	--Percent Stand-- Date 1989/90				
	9 Nov.	5 Dec.	19 Dec.	26 Dec.	3 Jan.
Syn3-88	13.5 b[2]	10.0 cd	14.3 bcd	18.8 c-f	48.8 bcd
National	23.7 ab	33.8 a	28.8 a	35.0 a	80.0 a
SR1019	11.0 bc	6.5 de	13.8 bcd	21.3 b-e	46.3 cd
Putter	8.8 bc	9.3 cde	13.8 bcd	22.5 bcd	55.0 bc
Penncross	8.0 bc	16.3 bc	19.3 b	27.5 ab	57.5 bc
Cobra	5.3 bc	5.5 de	10.5 cde	16.3 def	45.0 cd
SR1020	4.3 bc	8.0 de	12.5 cd	13.8 ef	40.0 de
PSU-126	3.3 c	5.3 de	8.8 de	13.8 ef	30.0 e
Southshore	3.0 c	3.5 de	11.0 cde	12.5 f	35.0 de
Seaside	1.0 c	10.0 cd	14.5 bc	26.3 bc	57.5 bc

[1]Parital data set, complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k=100.

Table 9. Quality ratings of Syn3-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989, by independent evaluators.

	Quality								
	Evaluator/Date								
	SG	RH	RH	SO	RW	DH	SM	WT	MM
Variety	3-1	3-29	3-30	4-3	4-4	4-7	5-31	6-20	6-20
Syn 3-88	4.5 cd[1]	6.5 a	7.5 a	5.6 ab	7.0 ab	7.8 a	8.0 a	7.7 a	7.8 a
Penncross	6.8 a	5.8 ab	6.3 a cd	5.9 a	6.0 abc	6.8 abc	5.0 cd	7.3 a	6.4 cde
SR1019	4.5 cd	6.0 ab	6.8 ab	5.3 ab	6.3 abc	7.0 abc	7.3 ab	7.2 a	7.1 a-d
SR1020	6.0 ab	5.5 abc	6.3 bcd	5.8 ab	5.8 bcd	7.5 ab	7.8 ab	7.5 a	7.3 abc
PSU126	3.5 de	5.0 bc	5.5 cde	4.8 ab	5.0 cde	6.5 abc	6.3 bc	7.1 a	7.4 ab
National	5.0 bc	3.3 d	4.0 f	5.0 ab	4.3 de	6.0 cd	4.5 d	7.4 a	4.9 f
Cobra	4.3 cd	5.0 bc	5.3 de	5.0 ab	5.3 cde	6.8 abc	6.3 bc	7.7 a	6.8 b-e
Southshore	4.0 cd	5.0 bc	6.5 abc	5.4 ab	5.8 bcd	6.3 bc	4.5 d	7.3 a	6.3 de
Seaside	3.5 de	3.5 d	4.0 f	4.6 ab	3.8 e	6.5 abc	2.8 ef	7.0 a	4.5 f
Putter	2.3 e	4.3 cd	5.0 ef	4.3 b	1.0 f	4.8 d	2.0 f	7.3 a	7.8 a

[1]Means within a column followed by the same letter are not significantly different using the Waller-Duncan multiple comparison procature (K ratio = 100). Quality rated 1-9, with 9 = best.

Table 9 cont. Quality ratings of Syn3-88 and nine cultivars of creeping bentgrass, TAES-Dallas 1989, by independent evaluators.

	Quality										
	Evaluator/Date										Phenotypic[2]
	PM	DN	TD	BC	KS	DD	SS	JB	WB	MS	Stability
Variety	7-12	7-12	8-27	9-8	9-8	9-8	9-8	10-4	10-4	10-4	--#(19 max)--
Syn 3-88	6.8 ab[1]	8.0 a	3.3 cd	8.0 ab	8.0 ab	8.0 a	7.5 a	3.8 e	3.0 bc	5.3 bc	14
Penncross	4.9 ef	5.5 d	4.3 abc	8.0 ab	8.0 ab	7.0 a	7.3 a	5.5 b-e	4.5 abc	6.0 abc	14
SR1019	5.6 cde	6.5 c	3.5 bcd	8.3 ab	8.3 ab	7.0 a	7.5 a	4.5 cde	2.8 bc	5.8 abc	12
SR1020	6.3 abc	7.0 bc	2.8 d	8.5 a	8.5 a	7.8 a	7.5 a	4.0 de	1.8 c	4.5 c	12
PSU 126	6.0 a-d	6.8 c	3.8 a-d	8.0 ab	8.0 ab	7.5 a	7.0 a	5.8 bcd	4.3 abc	6.3 abc	12
National	5.1 def	4.8 de	4.8 ab	8.0 ab	8.0 ab	8.0 a	8.5 a	7.3 ab	6.5 a	7.3 ab	10
Cobra	4.9 ef	5.5 d	3.8 a-d	8.3 ab	8.3 ab	7.3 a	7.3 a	5.3 cde	4.3 abc	5.5 bc	9
Southshore	5.8 b-e	5.5 d	4.3 abc	7.3 b	7.3 b	7.3 a	7.3 a	5.5 b-e	3.8 abc	5.8 abc	8
Seaside	3.0 g	4.3 e	5.0 a	7.3 b	7.3 b	7.0 a	7.8 a	6.0 abc	5.3 ab	7.0 ab	9
Putter	4.3 g	6.8 c	3.3 cd	8.5 a	8.5 a	8.0 a	8.3 a	5.5 b-e	4.0 abc	6.8 ab	8

[1]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k = 100. Quality rated 1-9, with 9 = best.
[2]Phenotypic Stability = number of occurrences a genotype was in top quality group for each date.

Table 10. Quality ratings of Syn3-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989, by TAES researchers.[1]

Cultivar	Date								
	28 Jan	29 Jan	30 Mar	27 Apr	11 Jun	28 Jun	21 Jul	22 Aug	26 Sept
	Quality								
Syn3-88	7.3 a[2]	7.3 a	7.5 a	7.5 a	7.5 a	8.0 a	6.8 a	6.8 a	6.1 abc
Penncross	6.8 a	6.8 a	5.3 bcd	4.5 de	4.5 de	4.8 ef	4.0 e	3.3 c-e	4.5 bcd
SR1019	6.0 ab	7.3 a	5.5 bc	6.0 bc	6.0 bc	7.8 ab	5.5 bc	5.8 ab	5.4 a-d
SR1020	5.0 b	6.3 ab	5.8 ab	7.0 ab	7.0 ab	8.3 a	6.3 ab	5.0 a-d	4.8 bcd
PSU126	5.0 bc	5.8 ab	5.3 b-d	5.5 cd	5.5 cd	6.8 bc	5.0 cd	4.5 b-e	5.9 abc
National	4.8 bc	6.0 ab	3.5 de	3.0 fg	3.0 fg	3.5 gh	3.5 e	4.8 a-e	5.9 abc
Cobra	4.5 bc	6.3 ab	5.3 bcd	5.3 cd	5.3 cd	6.0 cd	5.0 cd	4.9 a-e	5.6 a-d
Southshore	4.5 bc	6.0 ab	5.3 bcd	4.5 de	4.5 de	4.3 fgh	4.0 e	2.8 e	3.5 d
Seaside	4.5 bc	6.3 ab	3.3 e	2.0 g	2.0 g	3.3 h	2.5 f	3.1 de	4.1 cd
Putter	3.5 c	4.5 b	3.8 cde	3.5 ef	3.5 ef	4.5 efg	5.3 c	5.4 abc	5.3 a-d

[1]Parital data set, complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k = 100. Quality rated 1-9, with 9 = best.

Table 10 cont. Quality ratings of Syn3-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989-1990, by TAES researchers.[1]

Cultivar	Date								
	1989			1990					Phenotypic[3]
	23 Oct	25 Nov	3 Dec	27 Jan	13 Feb	16 Mar	4 Apr	1 May	Stability
	Quality								--#(17 Max)--
Syn3-88	6.7 ab[2]	6.8 a	5.5	6.3 abc	6.8 a	6.5 ab	5.8 ab	6.3 a-d	16
Penncross	4.3 cde	5.0 abc	5.3	5.3 bc	6.3 a	5.5 abc	4.9 abc	5.6 a-d	7
SR1019	5.0 bcd	5.8 ab	6.0	6.3 abc	6.8 a	7.0 ab	6.5 a	7.1 a	11
SR1020	5.5 abc	5.3 ab	4.0	6.0 abc	6.8 a	5.0 abc	5.9 ab	6.1 a-d	13
PSU126	6.3 ab	5.0 abc	5.5	6.3 abc	5.8 ab	5.6 abc	5.6 abc	5.8 a-d	9
National	4.0 cde	3.5 c	4.8	5.5 bc	4.3 bc	3.5 c	3.6 c	3.9 d	3
Cobra	4.3 cde	4.8 abc	5.8	5.0 cd	5.8 ab	4.8 abc	5.8 ab	4.5 bcd	7
Southshore	3.8 de	4.5 abc	4.0	5.0 cd	6.3 a	5.4 abc	4.4 bc	4.6 bcd	3
Seaside	2.8 e	2.8 c	3.8	3.3 d	3.8 c	4.3 bc	3.6 c	4.0 cd	1
Putter	6.1 ab	5.8 ab	6.5	7.5 a	7.0 a	6.1 ab	5.4 abc	6.9 ab	9

[1]Parital data set, complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test, where k = 100. Quality rated 1-9, with 9 = best.
[3]Phenotypic stability = number of occurrences a genotype was in top quality group for each date.

Table 11. Mean quality ratings of Syn3-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989, by 22 participants in the USGA summer research meetings.[1]

Variety	Rating	
Syn 3-88	5.7	bcd[1]
Penncross	5.1	ef
SR1019	4.8	f
SR1020	5.6	cd
PSU126	5.4	de
National	5.3	de
Cobra	5.4	de
Southshore	5.1	ef
Seaside	3.9	g
Putter	6.0	b

[1]Parital data set, complete data set includes two additional experimentals.
[2]Means followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k = 100. Quality rated 1-9, with 9 = best.

Table 12. Tiller number per core and leaf blade width of nine cultivars and Syn3-88 harvested from Dallas, TX in Oct. 1989 and March 1990.[1]

	Tiller		Leaf Blade Width	
	Date		Date	
Variety	Oct. 1989	March 1990	Oct. 1989	March 1990
	no.		mm	
Syn 3-88	19.3 bcd[2]	49.7 ab	0.79 ns[3]	0.96 ab
Pennlinks	21.7 ab	47.3 abc	0.87	1.02 ab
SR1019	19.8 bc	51.3 a	0.90	0.93 ab
Putter	18.7 bcd	45.2 c	0.87	0.91 ab
SR1020	18.7 bcd	51.7 a	0.81	0.90 b
Cobra	17.2 cde	38.8 def	0.89	0.91 ab
Penncross	16.7 cde	38.7 def	0.85	0.98 ab
National	16.4 de	34.5 ef	0.90	0.96 ab
Seaside	15.0 e	28.6 g	0.91	1.03 ab
Southshore	14.1 e	33.5 fg	0.85	1.01 ab

[1]Parital data set, complete data set includes two additional experimentals.
[2]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test where k = 100.
[3]Means are not significantly different using least square means F test.

Table 13. Mean quality ratings of Syn3-88 and seven cultivars of creeping bentgrass, Augusta, GA, 1989 and 1990.[1]

Cultivar	Quality Ratings: 5 July	30 Aug.	27 Sept.	16 Nov	22 Jan	27 Feb	23 Mar	17 Jul**	9 Aug**	PS' (7 max)
Syn 3-88	7.0 ab*	7.0 a	6.0 a	8.0 a	7.3 ns	7.3 ab	8.2 a	6.2	5.3	7
Penncross	5.0 de	4.8 bcd	4.7 cd	5.7 cd	7.0	4.0 e	6.0 c	5.2	4.3	1
SR1019	6.3 bc	5.5 bc	5.0 bc	5.7 cd	7.3	7.3 ab	7.5 ab	5.8	5.0	3
SR1020	7.5 a	5.7 b	5.5 ab	7.7 ab	7.7	7.7 a	7.2 abc	6.0	5.0	6
Pennlinks	4.8 e	4.7 cd	4.7 cd	6.0 cd	7.5	5.3 cde	6.7 bc	5.8	5.0	1
Cobra	4.8 e	4.8 bcd	4.3 de	5.7 cd	7.0	4.3 e	6.2 c	5.7	4.2	1
Seaside	5.0 de	4.3 d	3.8 e	5.0 d	7.0	4.0 e	6.7 bc	5.8	4.3	1
Putter	5.8 cd	4.3 d	4.5 cd	7.7 ab	7.2	5.3 cde	7.7 ab	5.7	4.5	3

[1]Parital data set, complete data set includes two additional experimentals.
[2]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test, where k = 100. ns=nonsignificant.
[3]Phenotypic Stability
[4]Data not analyzed

Table 14. Density of stand, thatch accumulation, and root length of Syn3-88 and seven bentgrass cultivars at Augusta, GA during 1989-90.

Cultivar	Density[2]	Thatch[3]	Length[3]
		--cm--	-cm x 10-
Syn 3-88	6.7 a*	0.63 ns	3.1 ab*
Putter	4.2 cd	0.37	2.7 ab
SR1019	4.8 c	0.47	2.9 ab
SR1020	5.7 b	0.50	3.0 ab
Seaside	3.7 d	0.45	2.2 b
Pennlinks	4.8 c	0.43	2.6 ab
Cobra	4.2 cd	0.47	3.3 a
Penncross	4.2 cd	0.43	2.9 ab

[1]Parital data set, complete data set includes two additional experimentals.
[2]Density ratings 1 to 9, 9 = highest. Notes taken 27 Sept. 1989.
[3]Thatch and root length measured on 16 Nov. 1989.
[4]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test where k = 100. ns = nonsignificant.

Table 15. Quality and disease evaluation of Syn3-88 and cultivars entered into the National Turfgrass Evaluation Program planted at Banyan Country Club, West Palm Beach, Florida during 1990.[1]

	------Quality------		
	----------Date----------		Disease[3]
Variety	16 Jan.	1 Mar.	
Syn3-88	7.5 a[2]	8.0 a	8.3 ab
UM8401	7.7 a*	7.7 ab	8.0 ab
Putter	7.3 ab	6.3 a-f	6.3 a-f
SR1020	7.0 abc	6.3 a-f	7.3 a-d
88.CBE	6.7 a-d	7.0 a-d	7.0 a-d
Forb89-12	6.3 a-c	6.7 a-e	7.0 a-d
88.CBL	6.3 a-d	6.0 a-f	5.7 b-g
WVPB89D15	6.0 a-e	7.3 abc	6.7 a-e
Carmen	6.0 a-e	5.3 c-g	6.3 a-f
MSCB-8	5.7 a-e	5.3 c-g	5.7 b-f
MSCB-6	5.3 a-e	4.7 efg	5.3 c-g
Cobra	5.3 a-e	5.0 d-g	5.3 c-g
Penncross	5.3 a-e	6.0 a-f	5.3 c-g
Tracenta	5.3 a-e	4.7 efg	6.3 a-f
National	5.0 b-e	5.7 b-g	5.3 c-g
Pennlinks	5.0 b-e	6.3 a-f	5.7 b-g
Allure	4.7 cde	4.7 efg	5.0 d-g
Providence	4.7 cde	6.7 a-e	4.3 e-h
Bardot	4.3 def	4.7 efg	5.0 d-g
Emerald	3.7 ef	5.0 d-g	4.0 fgh
Egmont	3.7 ef	4.3 fg	3.7 gh
BR1518	2.0 f	3.7 g	2.3 h

[1]Parital data set, complete data set includes two additional experimentals.
[2]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test where k = 100. ns = nonsignificant.
[3]Combined dollar spot and pythium damage, rating 1-9, where 9=no damage.

APPENDIX C

Syn4-88

ATTACHMENT C
Petition to Release

PLANT MATERIALS RELEASE PROPOSAL

Date 4 October 1990

1. CROP **Bentgrass** Type of Release **Varietal**

2. Proposed name or identification: **BRI or CATO**

3. Designation or name in development stages: **Syn4-88 or TAMU Syn88-4**

4. Primary features or advantages: Syn4-88 is a six clone synthetic, selected for its superior quality, density of turf and general performance for bentgrass greens in southern regions of the transition zone for turfgrasses. The variety has higher density, and more aggressive growth habits during summer months than Penncross or Pennlinks creeping bentgrasses (industry standards), the principle proprietary creeping bentgrass varieties presently used in the same area. From October 1988 through May 1990 (Figures 1 & 2), Syn4-88 ranked the highest in turfgrass performance more consistently than seven commercial cultivars in the same trials at TAES-Dallas, and Augusta, Georgia. Syn4-88 rated 7.7 (rating 1 to 9 with 9 = no pythium or dollar spot damage) in January 1990, superior to Pennlinks (5.7), or Penncross (5.3) (Table 15) in test at West Palm Beach, Florida.

5. Plant Variety Protection - suggested action: Certification required, process for Plant Variety Protection. Plant material will be transplanted to Seed Production Nursery, Oregon in fall 1990 with the initial (Yr-1) PVPA data submitted in the fall 1991, and the final data in the fall 1992.

6. Seed -- amount available and date: Approximately 30 pounds available 15 August 1990.

7. Provisions to maintain breeder seed: Pre-breeder/Breeder fields established in Oregon in 1989 with initial seed harvest in 1990. Second crop will be harvested in August 1991 (ca. ~150 - 200 pounds) with proposal to place in cold storage facilities. Sufficient seed to establish 100 - 200 acres foundation or base planting stock.

8. Proposed seed distribution: To Foundation Seed Service (FSS) for fall 1990 increase of 10+ acres of Breeder/Foundation Stock and license to single company for marketing, production, and distribution.

9. Suggested Fees (for Breeder or Genetic Stock): $20,000 + License

10. Supportive documents attached:

Release proposal XXXX Draft Misc. Pub. _____ Draft Variety Leaflet _____
Memo of Agreement ____ Proposed Distribution List ____

11. Release Proposal - prepared with or reviewed by: Dr. V. G. Lehman, Dr. Richard White, Dr. Bridget Ruemmele, Dr. James A. Reinert.

12. Suggested Reviewers: In Texas and U.S. (Names and Locations):

Dr. James Read - TAES- Dallas
Dr. Terrance Riordan - Nebraska
Dr. Victor Gibeault - California
Dr. Michael P. Kenna - Oklahoma

Submitted by:
Breeder and Scientists- Unit Head

M. C. Engelke _____ James A. Reinert _____

V. G. Lehman _____

_____ Authorship and % Contribution by each:

V. G. Lehman (____%) _____
Plant Breeder, Lofts Corporation, Formerly Research Associate, TAES-Dallas

M. C. Engelke (____%) _____
Associate Professor, TAES-Dallas

C. Mays (____%)_____
Former Superintendent, Brookhollow Country Club (Dallas)

SYN4-88 CREEPING BENTGRASS[5]

V. G. Lehman, M. C. Engelke, and C. Mays[6]

'Syn4-88' creeping bentgrass (Agrostis stolonifera subsp. palustris Huds.) was developed and released by the Texas Agricultural Experiment Station in 1990. Syn4-88 will be suitable for use as a cool-season turfgrass for putting surfaces and fairways throughout the usual area of adaptation of creeping bentgrass, with improved adaptation to the Southern Transition zone. Syn4-88 is a six-clone synthetic variety selected from an original 92 clone germplasm nursery.

Following extensive agronomic selection and evaluation at TAES-Dallas, a 50-clone elite germplasm nursery was established in Oregon in the fall of 1985 to evaluate seed production potential. Six parental clones from these 50 genotypes were selected based on floral niching and plant type in Tangent, Oregon during the 1986 and 1987 growing seasons. The parental clones were physically isolated in January 1988 in Oregon with the first seed harvest in August 1988 (pre-breeder seed). The parental clones, originating from Michigan and Texas, were designated as TAES-1198, TAES-1247, TAES-1252, TAES-2758, TAES-2761, and TAES-2897 (Table 1). Seed was harvested by maternal clone, with an equal quantity of seed from each parent being bulked to form the pre-breeder seed.

Approximately 2000 seedlings were established as transplants in a 0.13 ha breeder/pre-breeder field in Oregon in January 1989. Additional roguing for uniformity of plant type and flowering date of the breeder field during 1989 and 1990 resulted in the breeder stock of Syn4-88 (Generation 1). Seed harvested and established from this generation will produce Foundation Class (Generation 2), which in turn will be used to produce Registered or Certified Class (Generation 3). Either Registered or Certified seed will be used for the market class. Production from Foundation fields should be limited to 3 years, after which the field may be downgraded to certified for an additional 3 years of production. Certified production is limited to no more than 7 years from date of planting to ensure genetic purity and integrity.

The six parental clones of Syn4-88 were evaluated under greenhouse conditions for morphological characters in 1985 (Table 1). The

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[5]Syn4-88 was developed by the Texas Agricultural Experiment Station with partial funding from the United States Golf Association and Bentgrass Research, Inc.

[6]Turfgrass Breeder, Lofts Great Western Seed Co., Albany, OR (former Research Associate, TAES-Dallas), Associate Professor, Texas A&M Research and Extension Center, Dallas, Texas; and green keeper, Brookhollow Country Club, Dallas, Texas, respectively.

parents had high density with an aggressive spread rating, fine leaf type, with variable ligule lengths in comparison to the other 86 clones evaluated. Under field conditions, the parents were middle or higher in quality ratings across dates of evaluation as compared to the other 86 clones of bentgrass (Tables 2 and 3). Three of the parents were higher than 'Penncross' in thatch accumulation when evaluated in 1987 under green conditions (Table 4). Four of the parental clones produced adequate levels of seed germination and seed yield when grown in Tangent, OR in a polycross nursery containing 50 clones (Table 5). The parental clones of Syn4-88 were evaluated to determine date of heading (Table 6), with all clones initiating heading within 17 days of each other. Five of the parents of Syn4-88 rated high in seedhead numbers when evaluated in Tangent, OR, 1987, with three of the clones having an aggressive spread rating (Table 7).

Plants measuring 25-30 cm in diameter with a 15 - 20 cm soil base were dug and transplanted into an isolated crossing block in January 1988. The crossing block was composed of two replications of each clone randomly placed to enhance cross pollination. Seed was harvested by maternal clone and later bulked in equal quantities from each clone to create the variety designated 'Syn4-88'.

Turf plots were established at Augusta, GA and Dallas, TX under putting green management in the fall of 1988 to compare Syn4-88 with nine commercial cultivars and two additional experimental varieties. Data from experimental varieties have been omitted from subsequent tables to prevent complications with disclosure prior to their release. Seeding rate was 49 g are^{-1}. Syn4-88 was in the lowest grouping of varieties relative to stand establishment in Dallas in 1988 (Table 8). Quality was rated from 1 to 9 with 9=best in the turf evaluations.

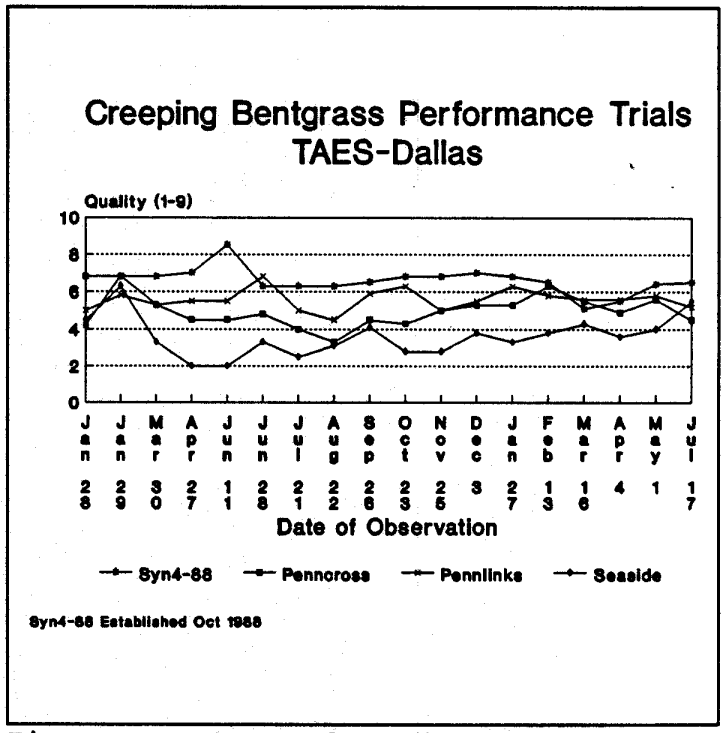

Figure 1. Seasonal performance of Syn4-88 at TAES-Dallas January 1989 through July 1990.

The accumulated performance of each entry is reflected in a parameter identified as Phenotypic Stability (PS). Phenotypic Stability is defined as the frequency or the number of times the entry performed in the highest (best) statistical grouping regardless of the character measured. Syn4-88 had the highest phenotypic stability when evaluated in Dallas by non-Texas A&M affiliated evaluators (Table 9). These outside evaluators included golf professionals, golf course superintendents, seed salesmen, seed producers, and two other turf scientists. When evaluated by Texas A&M researchers in Dallas, Syn4-88 also ranked high (16 of 17) in phenotypic stability (Table 10) and was consistently superior to Penncross, Pennlinks or 'Seaside' from January 1989 to the present (Figure 1).

When evaluated by 22 participants of the USGA 1989 summer meetings, Syn4-88 had a mean quality of 6.7, compared to 'Penncross' at 5.1. Syn4-88 had 23.3 and 42.8 tillers per 0.6 cm soil core, respectively, in October 1989 and March 1990 (Table 12). Leaf blade width was not significantly different from Penncross in October 1989 or March 1990 (Table 12).

Mean quality evaluations in Augusta, GA indicated that the variety SR1020 was performing better than Syn4-88 with a higher density rating 27 September 1989 (Table 13). Syn4-88 illustrated no significant differences in thatch accumulation from the other varieties at Augusta, GA in 1989-90 (Table 14). Syn4-88 was planted in 1989 in Florida, Mississippi, and Massachusetts in conjunction with the National Turfgrass Evaluation Program (NTEP). Syn4-88 was planted in Tucson, Arizona, and Griffin, Georgia in 1990 (Figure 3).

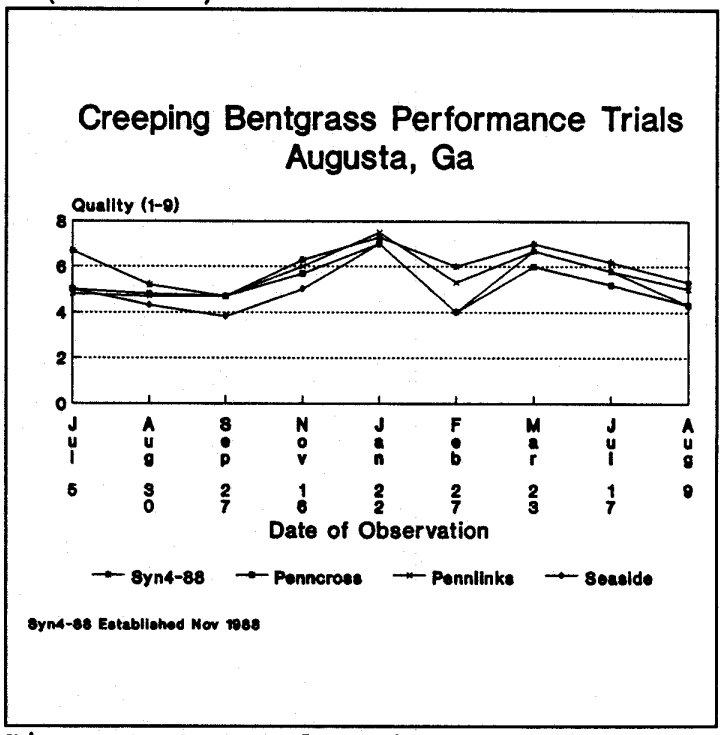

Figure 2. Seasonal performance of Syn4-88 at August, Ga from July 1989 through August 1990.

When evaluated at Banyan Country Club in the NTEP bentgrass trial during the spring of 1990, Syn4-88 was in the highest quality ranking and was not as susceptible to combined dollar spot and Pythium spp. disease as some other varieties (Table 15).

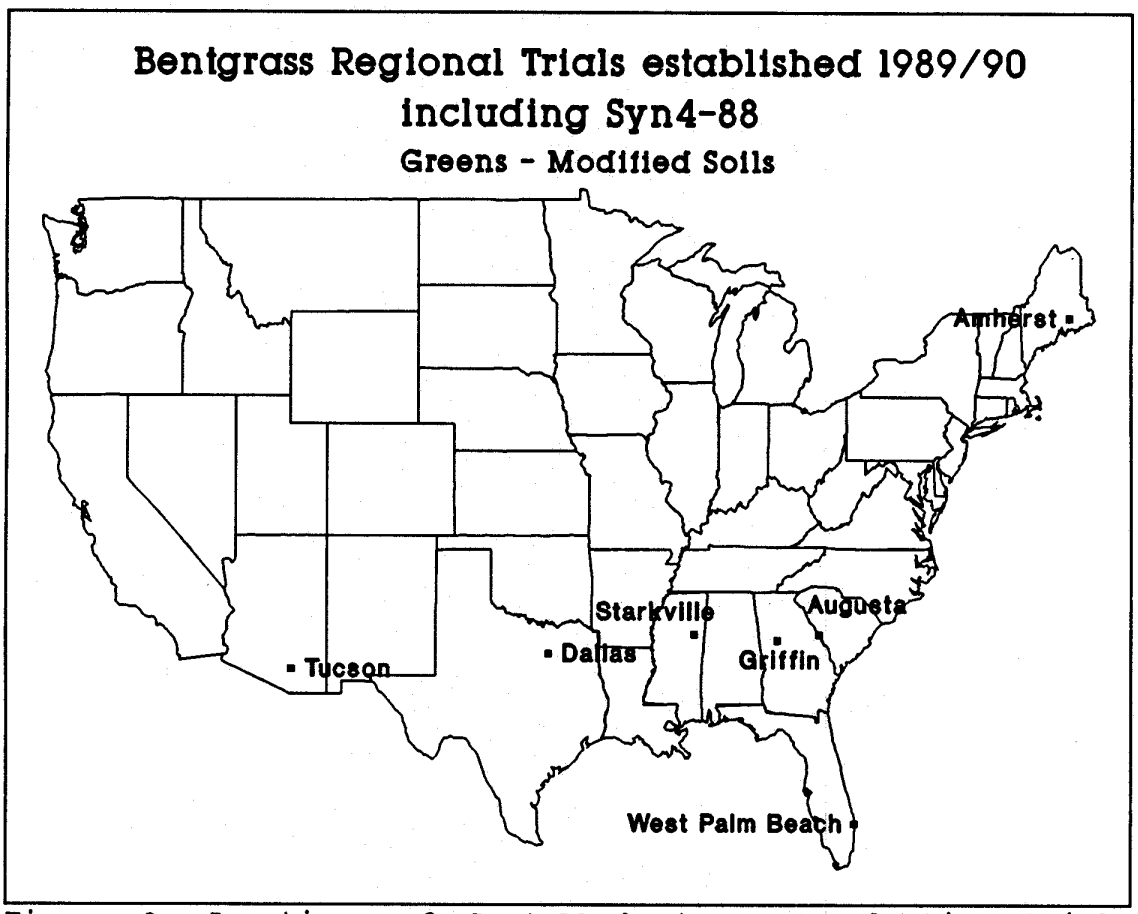

Figure 3. Locations of Syn4-88 bentgrass evaluation trials established in 1989/90.

Syn4-88 has been included in selected sites across the United States in conjunction with the Bentgrass national trials conducted through the National Turf Evaluation Program and the Maryland Turfgrass Council (Figure 3). These trials were established in 1989, but due to a lack of sufficient seed, it was necessary to plant Syn4-88 at selected locations in 1989 and others in 1990. To date, all trials have been fully established.

Syn4-88 is genetically different from the other commercially available varieties, as illustrated by the performance data in this document. Breeder's seed will be available in August 1990.

Table 1. Morphological characterization of parental clones of Syn4-88 grown in a greenhouse, taken 30 July 1985.[1,2]

Accession	Origin	Density[3]	Growth Type[4]	Spread[5]	Spread Type[6]	Leaf Width[7]	Ligule Length[8]
1198	MI	2	U	3	T	1.4	1.1
1247	TX	2	I	3	S	1.3	1.3
1252	TX	2	I	3	S	1.2	1.0
2758	TX	2	U	2	T	1.1	1.0
2761	TX	3	I	3	S	1.2	1.1
2897	MI	3	P	3	S/T	1.2	1.1

[1]Parental clone data extracted from analysis including 92 clones of original germplasm nursery
[2]Non-replicated trial, but multiple measures per tray.
[3]Density rated 1-3, 3=best.
[4]Growth type where P=prostrate, U=upright, I=intermediate.
[5]Spread rated 1-3, 3=most.
[6]Type of spread, T=Tillers, S=Stolons.
[7]Ligule, mean of 3 ligule lengths.
[8]Leaf width, mean of 3 leaf widths.

Table 2. Mean quality under putting green conditions at TAES-Dallas of Syn4-88 parental clones, 1985-1986.[1]

	Date						
	1985	1986					1986
Accession	088	016	069	111	146	175	Mean
	Quality (1-9, 9=best)						
1198	3.0 fg	5.5 b-g	7.0 a-d	6.5 a-e	7.5 a-d	5.0 f-l	6.3 m-u
1247	8.0 ab	5.5 b-g	8.5 a	8.5 a	9.0 a	8.5 ab	8.0 ab
1252	6.0 a-f	5.5 b-g	7.0 a-d	7.0 a-d	8.0 a-d	7.0 b-e	7.1 a-j
2758	5.0 a-g	7.5 abc	6.5 a-e	6.5 a-e	8.0 abc		6.4 h-u
2761	2.5 fg	6.5 a-e	6.0 a-e	6.5 a-e	5.5 e-h	7.0 b-d	5.6 r-z
2897	4.5 b-g	7.5 abc	8.0 ab	8.5 a	7.5 a-d	7.5 a-d	6.6 e-q
Range	2.0-8.5	1.0-8.5	8.5-3.0	2.5-8.5	2.0-9.0	1.0-9.0	2.4-9.0
Penncross	.	.	.	5.5	7.0	8.0	

[1]Parental clone data extracted from analysis including 92 clones of original germplasm nursery.

Table 3. Mean quality under putting green conditions at TAES-Dallas of Syn4-88 parental clones, 1987-1988.[1]

Accession	DATE 1987 Mean	1988 Mean
	----- Quality (1-9, 9=best) ----	
1198	5.3 ab[2]	6.0 b-f
1247	7.0 a	7.5 abc
1252	6.3 ab	7.5 abc
2758	4.3 ab	7.5 abc
2761	5.0 ab	7.0 a-d
2897	5.2 ab	7.0 a-d
Range	1.6-7.2	1.5-8.0
Penncross	5.3 ab	5.0 d-h

[1]Parental clones data extracted from analysis including all 92 clones
[2]Means followed by the same letter are not significantly different using the Waller-Duncan k ratio t test (k=100).

Table 4. Mean depth and weight of thatch layer of parental clones of Syn4-88 taken 17 June 1987 from a 20 mm by 77 mm soil slice at TAES-Dallas.[1]

Accession	Depth	Weight
	- mm -	- mg -
1198	7.8	14.8
1247	9.0 a[2]	15.5 a
1252	8.0	14.3
2758	10.0 a	16.0 a
2761	9.5 a	16.0 a
2897	.	.
Range	5.3-10.0	13.3-16.5
Penncross	7.8	15.0 a

[1]Parental clone data extracted form analysis including all 92 clones.
[2]Means followed by an "a" were in the highest statistical grouping at the k=100 level using the Waller/Duncan k ratio t test.

Table 5. Germination and seed yield of the parental clones of Syn4-88, grown in Tangent, OR, 1986.[1]

Accession	Germination[2]	Seed yield[3]
	--Percent--	--g/plant--
1198	85	0.54
1247	80	3.60
1252	71	2.40
2758	65	4.40
2761	57	3.89
2897	.	.
Range	50-91	0.0-6.83

[1]Parental clone data extracted from analysis including all 92 clones.
[2]3 Petri plates of 100 seeds counted after 7 days of hydration. One application of Subdue for Pythium spp. control.
[3]Mean seed yield per plant with 3 plants per parent.

Table 6. Mean heading date of parental clones of Syn4-88, by replication in Tangent, OR, in 1987.

Accession	Replication		
	I	II	III
	month - day		
1198	6-12	6-15	6-14
1247	6-9	5-28	6-3
1252	6-6	6-5	5-29
2758	6-4	6-1	5-28
2761	6-6	6-3	6-4
2897	6-12	6-14	6-12

Table 7. Mean seedhead, spread and growth habit (9=erect) rating of parental clones of Syn4-88 at Tangent, OR, in 1987.

Accession	Seedhead	Spread	Growth Habit
	Rating 1-9, 9=best		
1198	5.0[1]	6.3 a	6.0 a
1247	7.3 a	5.7	2.3
1252	7.7 a	5.0	2.3
2758	9.0 a	6.3 a	2.3
2761	6.7 a	4.3	2.3
2897	8.0 a	7.7 a	4.0
Range	0.0-9.0	1.7-9.0	1.0-8.3

[1]Means followed by an 'a' in the same column were in the highest statistical grouping at the k=100 level using Waller Duncan k ratio t test.

Table 8. Percent stand and quality ratings of Syn4-88 and nine cultivars of creeping bentgrass. Seed of each was planted at a rate of 49 g are^{-1} on 31 October 1988 in a randomized complete block design with four replications.[1]

Variety	1989				1990
	9 Nov.	5 Dec.	19 Dec.	26 Dec.	3 Jan.
	Percent Stand				
Syn4-88	2.0 c[2]	2.0 e	5.5 e	12.5 f	26.3 e
National	23.7 ab	33.8 a	28.8 a	35.0 a	80.0 a
SR1019	11.0 bc	6.5 de	13.8 bcd	21.3 b-e	46.3 cd
Putter	8.8 bc	9.3 cde	13.8 bcd	22.5 bcd	55.0 bc
Penncross	8.0 bc	16.3 bc	19.3 b	27.5 ab	57.5 bc
Cobra	5.3 bc	5.5 de	10.5 cde	16.3 def	45.0 cd
SR1020	4.3 bc	8.0 de	12.5 cd	13.8 ef	40.0 de
PSU-126	3.3 c	5.3 de	8.8 de	13.8 ef	30.0 e
Southshore	3.0 c	3.5 de	11.0 cde	12.5 f	35.0 de
Seaside	1.0 c	10.0 cd	14.5 bc	26.3 bc	57.5 bc

[1]Partial data set, complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k=100.

Table 9. Quality ratings of Syn4-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989, by independent evaluators.[1]

	Evaluator/Date								
Variety	SG 3-1	RH 3-29	RH 3-30	SO 4-3	RW 4-4	DH 4-7	SM 5-31	WT 6-20	MM 6-20
	Quality (1-9, 9=best)								
Syn4-88	3.8 cd[2]	6.0 a	6.8 a	5.3 ab	7.5 ab	7.3 a	7.0 a	7.7 a	8.0 a
Penncross	6.8 a	5.8 ab	6.3 bcd	5.9 a	6.0 abc	6.8 abc	5.0 cd	7.3 a	6.4 cde
SR1019	4.5 cd	6.0 ab	6.8 ab	5.3 ab	6.3 abc	7.0 abc	7.3 ab	7.2 a	7.1 a-d
SR1020	6.0 ab	5.5 abc	6.3 bcd	5.8 ab	5.8 bcd	7.5 ab	7.8 ab	7.5 a	7.3 abc
PSU126	3.5 de	5.0 bc	5.5 cde	4.8 ab	5.0 cde	6.5 abc	6.3 bc	7.1 a	7.4 ab
National	5.0 bc	3.3 d	4.0 f	5.0 ab	4.3 de	6.0 cd	4.5 d	7.4 a	4.9 f
Cobra	4.3 cd	5.0 bc	5.3 de	5.0 ab	5.3 cde	6.8 abc	6.3 bc	7.7 a	6.8 b-e
Southshore	4.0 cd	5.0 bc	6.5 abc	5.4 ab	5.8 bcd	6.3 bc	4.5 d	7.3 a	6.3 de
Seaside	3.5 de	3.5 d	4.0 f	4.6 ab	3.8 e	6.5 abc	2.8 ef	7.0 a	4.5 f
Putter	2.3 e	4.3 cd	5.0 ef	4.3 b	1.0 f	4.8 d	2.0 f	7.3 a	7.8 a

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan multiple comparison procedure (K ratio = 100). Quality rated 1-9, with 9 = best.

Table 9 (cont). Quality ratings of Syn4-88 and nine cultivars of creeping bentgrass, TAES-Dallas 1989, by independent evaluators.

	Evaluator/Date										Phenotypic[3] Stability
Variety	PM 7-12	DN 7-12	TD 8-27	BC 9-8	KS 9-8	DD 9-8	SS 9-8	JB 10-4	WB 10-4	MS 10-4	--#(19 max)--
	Quality (1-9, 9=best)										
Syn4-88	7.0 a[2]	7.8 ab	3.0 cd	8.5 ab	8.5 ab	8.0 a	7.3 a	5.3 e	4.8 bc	6.8 ab	15
Penncross	4.9 ef	5.5 d	4.3 abc	8.0 ab	8.0 ab	7.0 a	7.3 a	5.5 b-e	4.5 abc	6.0 abc	13
SR1019	5.6 cde	6.5 c	3.5 bcd	8.3 ab	8.3 ab	7.0 a	7.5 a	4.5 cde	2.8 bc	5.8 abc	13
SR1020	6.3 abc	7.0 bc	2.8 d	8.5 a	8.5 a	7.8 a	7.5 a	4.0 de	1.8 c	4.5 c	12
PSU 126	6.0 a-d	6.8 c	3.8 a-d	8.0 ab	8.0 ab	7.5 a	7.0 a	5.8 bcd	4.3 abc	6.3 abc	12
National	5.1 def	4.8 de	4.8 ab	8.0 ab	8.0 ab	8.0 a	8.5 a	7.3 ab	6.5 a	7.3 ab	10
Cobra	4.9 ef	5.5 d	3.8 a-d	8.3 ab	8.3 ab	7.3 a	7.3 a	5.3 cde	4.3 abc	5.5 bc	9
Southshore	5.8 b-e	5.5 d	4.3 abc	7.3 b	7.3 b	7.3 a	7.3 a	5.5 b-e	3.8 abc	5.8 abc	8
Seaside	3.0 g	4.3 e	5.0 a	7.3 b	7.3 b	7.0 a	7.8 a	6.0 abc	5.3 ab	7.0 ab	9
Putter	4.3 g	6.8 c	3.3 cd	8.5 a	8.5 a	8.0 a	8.3 a	5.5 b-e	4.0 abc	6.8 ab	8

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k = 100. Quality rated 1-9, with 9 = best.
[3]Phenotypic Stability = number of occurrences a genotype was in top quality group for each date.

Table 10. Quality ratings of Syn4-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989, by TAES researchers.[1]

Cultivar	Date								
	28 Jan	29 Jan	30 Mar	27 Apr	11 Jun	28 Jun	21 Jul	22 Aug	26 Sept
	Quality (1-9, 9=best)								
Syn4-88	4.2 c[2]	6.8 a	6.8 ab	7.0 ab	7.0 ab	8.5 a	6.3 ab	6.3 ab	6.5 ab
Penncross	6.8 a	6.8 a	5.3 bcd	4.5 de	4.5 de	4.8 ef	4.0 e	3.3 c-e	4.5 bcd
SR1019	6.0 ab	7.3 a	5.5 bc	6.0 bc	6.0 bc	7.8 ab	5.5 bc	5.8 ab	5.4 a-d
SR1020	5.0 b	6.3 ab	5.8 ab	7.0 ab	7.0 ab	8.3 a	6.3 ab	5.0 a-d	4.8 bcd
PSU126	5.0 bc	5.8 ab	5.3 b-d	5.5 cd	5.5 cd	6.8 bc	5.0 cd	4.5 b-e	5.9 abc
National	4.8 bc	6.0 ab	3.5 de	3.0 fg	3.0 fg	3.5 gh	3.5 e	4.8 a-e	5.9 abc
Cobra	4.5 bc	6.3 ab	5.3 bcd	5.3 cd	5.3 cd	6.0 cd	5.0 cd	4.9 a-e	5.6 a-d
Southshore	4.5 bc	6.0 ab	5.3 bcd	4.5 de	4.5 de	4.3 fgh	4.0 e	2.8 e	3.5 d
Seaside	4.5 bc	6.3 ab	3.3 e	2.0 g	2.0 g	3.3 h	2.5 f	3.1 de	4.1 cd
Putter	3.5 c	4.5 b	3.8 cde	3.5 ef	3.5 ef	4.5 efg	5.3 c	5.4 abc	5.3 a-d

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k = 100. Quality rated 1-9, with 9 = best.

Table 10 (cont.) Quality ratings of Syn4-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989-1990, by TAES researchers.[1]

Cultivar	DATE								Phenotypic[3] Stability
	1989			1990					
	23 Oct	25 Nov	3 Dec	27 Jan	13 Feb	16 Mar	4 Apr	1 May	--#(17 Max)--
	Quality (1-9, 9=best)								
Syn4-88	6.8 a[2]	6.8 a	7.0 a	6.8 ab	6.5 a	5.1 abc	5.5 abc	6.4 abc	16
Penncross	4.3 cde	5.0 abc	5.3 a	5.3 bc	6.3 a	5.5 abc	4.9 abc	5.6 a-d	7
SR1019	5.0 bcd	5.8 ab	6.0 a	6.3 abc	6.8 a	7.0 ab	6.5 a	7.1 a	11
SR1020	5.5 abc	5.3 ab	4.0 a	6.0 abc	6.8 a	5.0 abc	5.9 ab	6.1 a-d	13
PSU126	6.3 ab	5.0 abc	5.5 a	6.3 abc	5.8 ab	5.6 abc	5.6 abc	5.8 a-d	9
National	4.0 cde	3.5 c	4.8 a	5.5 bc	4.3 bc	3.5 c	3.6 c	3.9 d	3
Cobra	4.3 cde	4.8 abc	5.8 a	5.0 cd	5.8 ab	4.8 abc	5.8 ab	4.5 bcd	7
Southshore	3.8 de	4.5 abc	4.0 a	5.0 cd	6.3 a	5.4 abc	4.4 bc	4.6 bcd	3
Seaside	2.8 e	2.8 c	3.8 a	3.3 d	3.8 c	4.3 bc	3.6 c	4.0 cd	1
Putter	6.1 ab	5.8 ab	6.5 a	7.5 a	7.0 a	6.1 ab	5.4 abc	6.9 ab	9

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means within a column followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test, where k = 100. Quality rated 1-9, with 9 = best.
[3]Phenotypic stability = number of occurrences a genotype was in top quality group for each date.

Table 11. Mean quality ratings of Syn4-88 and nine cultivars of creeping bentgrass, TAES-Dallas, 1989, by 22 participants in the USGA summer research meetings[1].

Cultivar	Quality (1-9, 9=best)
Syn4-88	6.7 a[2]
Penncross	5.1 ef
SR1019	4.8 f
SR1020	5.6 cd
PSU126	5.4 de
National	5.3 de
Cobra	5.4 de
Southshore	5.1 ef
Seaside	3.9 g
Putter	6.0 b

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means followed by the same letter are not significantly different using the Waller-Duncan k-ratio t test where k = 100. Quality rated 1-9, with 9 = best.

Table 12. Tiller number per core and leaf blade width of nine cultivars and Syn4-88 harvested from Dallas, TX in Oct. 1989 and March 1990.[1]

	Tiller		Leaf Blade Width	
	Date		Date	
Cultivar	Oct. 1989	March 1990	Oct. 1989	March 1990
	----------no.---------		----------mm---------	
Syn4-88	23.3 a[2]	42.8 cd	0.85 ns[3]	0.90 b
Pennlinks	21.7 ab	47.3 abc	0.87	1.02 ab
SR1019	19.8 bc	51.3 a	0.90	0.93 ab
Putter	18.7 bcd	45.2 c	0.87	0.91 ab
SR1020	18.7 bcd	51.7 a	0.81	0.90 b
Cobra	17.2 cde	38.8 def	0.89	0.91 ab
Penncross	16.7 cde	38.7 def	0.85	0.98 ab
National	16.4 de	34.5 ef	0.90	0.96 ab
Seaside	15.0 e	28.6 g	0.91	1.03 ab
Southshore	14.1 e	33.5 fg	0.85	1.01 ab

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test where k = 100.
[3]Means are not significantly different using least square means F test.

Table 13. Mean quality ratings of Syn4-88 and seven cultivars of creeping bentgrass, Augusta, GA, 1989 and 1990.[1]

Cultivar	DATE									Phenotypic Stability[4]
	5 July	30 Aug.	27 Sept.	16 Nov	22 Jan	27 Feb	23 Mar	17 Jul[3]	9 Aug[3]	--#(7 Max)--
	Quality (1-9, 9=best)									
Syn4-88	6.7 abc[1]	5.2 bcd	4.7 cd	6.3 c	7.3 ns	6.0 bc	7.0 bc	6.2	5.3	2
Penncross	5.0 de	4.8 bcd	4.7 cd	5.7 cd	7.0	4.0 e	6.0 c	5.2	4.3	1
SR1019	6.3 bc	5.5 bc	5.0 bc	5.7 cd	7.3	7.3 ab	7.5 ab	5.8	5.0	3
SR1020	7.5 a	5.7 b	5.5 ab	7.7 ab	7.7	7.7 a	7.2 abc	6.0	5.0	6
Pennlinks	4.8 e	4.7 cd	4.7 cd	6.0 cd	7.5	5.3 cde	6.7 bc	5.8	5.0	1
Cobra	4.8 e	4.8 bcd	4.3 de	5.7 cd	7.0	4.3 e	6.2 c	5.7	4.2	1
Seaside	5.0 de	4.3 d	3.8 e	5.0 d	7.0	4.0 e	6.7 bc	5.8	4.3	1
Putter	5.8 cd	4.3 d	4.5 cd	7.7 ab	7.2	5.3 cde	7.7 ab	5.7	4.5	3

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test, where k = 100. ns=nonsignificant.
[3]Data not analyzed
[4]Phenotypic Stability

Table 14. Density of stand, thatch accumulation, and root length of Syn4-88 and seven bentgrass cultivars at Augusta, GA during 1989-90.[1]

Cultivar	Density[2]	Thatch[3]	Length[3]
		--cm--	-cm x 10-
Syn4-88	4.2 c[4]	0.42 ns	3.1 ab
Putter	4.2 cd	0.37	2.7 ab
SR1019	4.8 c	0.47	2.9 ab
SR1020	5.7 b	0.50	3.0 ab
Seaside	3.7 d	0.45	2.2 b
Pennlinks	4.8 c	0.43	2.6 ab
Cobra	4.2 cd	0.47	3.3 a
Penncross	4.2 cd	0.43	2.9 ab

[1]Partial data set; complete data set includes two additional experimentals.
[2]Density ratings 1 to 9, 9 = highest. Notes taken 27 Sept. 1989.
[3]Thatch and root length measured on 16 Nov. 1989.
[4]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test where k = 100. ns = nonsignificant.

Table 15. Quality and disease evaluation of Syn4-88 and cultivars entered into the National Turfgrass Evaluation Program planted at Banyan Country Club, West Palm Beach, Florida during 1990.[1]

Variety	Date		Disease[3]
	16 Jan.	1 Mar.	
	-- Quality (1-9, 9=best) --		
Syn4-88	7.0 abc[2]	7.3 abc	7.7 abc
UM8401	7.7 a	7.7 ab	8.0 ab
Putter	7.3 ab	6.3 a-f	6.3 a-f
SR1020	7.0 abc	6.3 a-f	7.3 a-d
88.CBE	6.7 a-d	7.0 a-d	7.0 a-d
Forb89-12	6.3 a-c	6.7 a-e	7.0 a-d
88.CBL	6.3 a-d	6.0 a-f	5.7 b-g
WVPB89D15	6.0 a-e	7.3 abc	6.7 a-e
Carmen	6.0 a-e	5.3 c-g	6.3 a-f
MSCB-8	5.7 a-e	5.3 c-g	5.7 b-f
MSCB-6	5.3 a-e	4.7 efg	5.3 c-g
Cobra	5.3 a-e	5.0 d-g	5.3 c-g
Penncross	5.3 a-e	6.0 a-f	5.3 c-g
Tracenta	5.3 a-e	4.7 efg	6.3 a-f
National	5.0 b-e	5.7 b-g	5.3 c-g
Pennlinks	5.0 b-e	6.3 a-f	5.7 b-g
Allure	4.7 cde	4.7 efg	5.0 d-g
Providence	4.7 cde	6.7 a-e	4.3 e-h
Bardot	4.3 def	4.7 efg	5.0 d-g
Emerald	3.7 ef	5.0 d-g	4.0 fgh
Egmont	3.7 ef	4.3 fg	3.7 gh
BR1518	2.0 f	3.7 g	2.3 h

[1]Partial data set; complete data set includes two additional experimentals.
[2]Means followed by the same letter in the same column are not significantly different using the Waller-Duncan k-ratio t test where k = 100. ns = nonsignificant.
[3]Combined dollar spot and pythium damage, rating 1-9, where 9=no damage.